THE TELEGRAPHIC JOURNAL AND

Electrical Review.

VOL. XVIII.—No. 431.

JULES JAMIN.

THE Académie des Sciences, a body much less numerous than our Royal Society, has latterly sustained an exceptional series of losses in the persons of its most eminent members. Dumas, Thenard, Wurtz, Milne-Edwards, Robin—to name only those best known in this country—have passed away, leaving their places to be filled and their researches to be continued by others. The latest, and certainly not the least regretted of these losses, is that of Jules Jamin. Called to the Perpetual Secretaryship on the death of his illustrious master, Dumas, he discharged the onerous and delicate functions of this high office to the general satisfaction of his colleagues and of the scientific world; and, though in his sixty-eighth year, his demise was no less unexpected than unwelcome.

Jules Jamin was born at Termes, in the Ardennes, May 31st, 1818. He commenced his education in a private school in the town of Vouziers. Thence he passed to the College of Rheims, gaining the highest honours, and in 1841 he left this establishment as "first agrégé" in the physical sciences. His subsequent progress was decisive. He filled with the highest credit the professorial chairs of physics at the Ecole Polytechnique, at the Sorbonne, and at the Faculté des Sciences. As a lecturer his success was remarkable. His clearness of exposition, his power of rendering even the most complicated theories clear to his hearers, will never be forgotten by his former pupils. The same attributes are displayed in his two systematic works *Traité général de physique*, which was a reproduction of his course at the Polytechnic, and his *petit Traité de physique*, where he explains the modern theories of the phenomena of light, heat, and electricity with admirable lucidity.

His researches embraced nearly all departments of physics. Perhaps to English electricians he is best known through the magnet of peculiar construction which bears his name, and his electric candle, which burns point downwards and is self-igniting. Besides his labours in optics, magnetism, and electricity, which constitute his highest claim to the notice of posterity—we remind our readers here that he was the first to complete a rational study of magneto-electric currents—his researches on the compressibility of liquids, on capillarity, hygrometry, specific heat, the critical point of gases, &c., attest the originality and the fertility of his genius. With him, as is happily said by his eulogist, M. L. Troost, teaching and discovering were identical. Nor must we forget that several of his pupils have been found ready to follow in his footsteps. Thus Blondlot has produced a valuable memoir on the "Capacity of Voltaic Polarisation," and Benoit has investigated the resistance of metals.

It may not be superfluous to remark that though a laborious and successful physicist, he was more: he was known also as a botanist and a geologist, and he found time also for metaphysics, literature, music, and the fine arts. There exist paintings from his hand not without merit. He insisted on the advantages of a closer approximation between the artist and the *savant*, united as they are by the common necessity of observing the optical appearances of natural objects. We cannot, in concluding this brief sketch of the illustrious dead, do other than express to our French fellow-labourers in the cause of science our profound sympathy for the loss they have sustained.

ELECTRIC LOCOMOTION.

By A. RECKENZAUN.

X.

UNDER fairly good conditions it is possible to work a tramline, as depicted in fig. 8, with conductors by means of a stationary steam engine of 150 H.P., and this will give an average expenditure of 12·5 H.P. per car. Each car when full of passengers weighs 5 tons, and it has to run at a constant speed of 6 miles per hour. A first-rate steam engine of this power need not use more than 3·5 lbs. of good coal per H.P. hour, therefore the consumption of fuel per car mile may be taken at $\frac{12{\cdot}5 \times 3{\cdot}5}{6} = 7{\cdot}3$ lbs. nearly.

This compares very favourably with that of a tramway steam locomotive where the consumption of fuel on a similar line will amount to about 10 lbs. per mile. The tests at Antwerp showed that the consumption of coal varied between 5·4 and 9·1 lbs per car mile, but this was on a perfectly level line. To explain the reason of this large expenditure of fuel we need only consider that the dead weight of a separate locomotive engine is some 8 or 9 tons, as compared with half a ton of machinery on the electric car which carries its own motor, and we have all along assumed that this electric motor is attached to the vehicle carrying the passengers. It must also be granted that a small steam locomotive engine will consume much more fuel to produce a given power, than a large stationary engine. The loss, therefore, occasioned by the conversion and the transmission of electric energy is more than compensated for by other advantages. We do not intend to convey the idea that electric propulsion will ever compete with large locomotive engines for main lines of railways, unless some wonderfully cheap method of producing electricity is discovered; but within the limits of this discussion we can feel assured that the electric systems of propulsion are sufficiently advanced to warrant a practical success under suitable circumstances, such as for elevated lines, tramways through country districts, or along the sea shores, as, for instance, Mr. Magnus Volk's railway at Brighton, and others in places where there is no other traffic.

We cannot too strongly dwell upon the fact that one of the principal advantages with electric cars is that the motor can so readily be placed underneath the vehicle, and that by this means we utilise the weight of the same, together with the weight of the passengers, for producing the requisite adhesion between the driving wheels and rails when mounting inclines. This has been clearly pointed out by Prof. Ayrton in his interesting lecture at the London Institution some four years ago, as also on several occasions by the late Sir William Siemens. It is, therefore, surprising that at this advanced period there should be money and brain power wasted, in America as well as in England, on schemes wherein separate electric locomotives are employed for the purpose of hauling passenger cars, thus throwing aside one of the greatest virtues which electric propulsion possesses. In order

to haul a vehicle upon ordinary rails with safety it is necessary that the hauling apparatus should weigh at least as much as the object attached to it; this law, of course, does not apply to railway trains composed of many carriages, and lines which are tolerably level, made as level as possible at any cost, but for tramway haulage it has been a long recognised fact. Whether this fact is simply ignored, or whether it is from mere ignorance we are unable to judge, but the sooner certain inventors and their supporters are made aware of it the better it will be for them and the cause they are advocating.

The space occupied by a pair of horses, or by a separate locomotive plays a part, in crowded thoroughfares, which is frequently lost sight of by the general public; but the *Railway Engineer* of February, 1883, gave some very interesting figures upon this point in an article on "Metropolitan Passenger Traffic," and we hope we are not transgressing by referring to a few of the passages. There is no mention made of electricity, but we believe the arguments are most suitable for this mode of propulsion. After some figures on the measurement of omnibuses, we read: "Bringing our thoughts now to bear on tramcars, we have also found by measurement that a tramcar and horses for 38 passengers occupy an area of 170 square feet, giving a mean ratio of 22·8 passengers per 100 square feet. But supposing the cars to be hauled by an underground cable, to which they may be fastened or unfastened by a clutch at will, so as to dispense with horses or locomotives, we have then only the area of the car itself to deal with. Those above alluded to would occupy 120 square feet of ground, giving a mean ratio of 31·6 passengers per 100 square feet of ground occupied. It is clearly shown that, as far as accommodation is concerned, tramcars, especially when the haulage power occupies no ground, have a most supreme advantage over any other street vehicle." The question of speed is also considered as important for the purpose of relieving the traffic, and there is no doubt that tramcars at present are slow and easily beaten by omnibuses. "Taking the speed of omnibuses at 8 miles per hour, trams with two horses must travel more than $7\frac{1}{2}$ miles, or without horses more than $5\frac{1}{8}$ miles per hour to be more effective." After dealing with statistics of vehicular traffic in crowded thoroughfares, the article concludes thus: "In dealing with the subject of tramways it has been our principal object to point out how they form a natural gradation between the railway train and the road vehicle.

"Tramcars are much more roomy than omnibuses and the motion is far more easy. Coming as they do halfway between trains and road vehicles, they are better adapted by their nature to combine the advantages of both. It only remains for them to increase their speed, though, of course, not without regard to safety to other vehicles. But they may, at any rate, keep pace with omnibuses, and we would emphasise the necessity of speed as much for the popularity of the tram system that would thereby be induced, as for any other consideration.

"To make them popular is most important, as it is plain that their economy of ground space can be of no avail if the public are not attracted into their use. Economy of ground space they have, and comfort, and *speed* is what is next required to render them the most effectual means of relieving street passenger traffic that is in existence. Properly developed and brought to a state nearer perfection, there can be no doubt that tramways, like railways, must materially tend to the general advancement of our great towns."

We need not point out that electricity, especially when the energy can be carried within the vehicle, is destined to play a most important part in the development of tramways. Electricity is decidedly cheaper than horseflesh, and it has none of the drawbacks which are to be found in steam or any other means of mechanical traction. It is a question of deciding upon one system or another in every case; for short suburban lines, as already stated, conductors may be found suitable; but for populous streets and districts the insulated conductor involves difficulties, and the more advantageous under these circumstances will be the system in which secondary batteries are employed where the store of energy is carried in the car under the seats. There are certain objections to be disposed of in connection with the utilisation of secondary batteries, and we propose to deal with these objections *seriatim*. One of the most popular objections is the weight of these batteries; and it has been often predicted that this is so serious that it is folly to occupy oneself with this idea of transmitting electric energy. Men of reputation in the scientific world have endeavoured to prove by calculations that nothing can ever come of such a scheme, not merely on account of the great weight but also on account of the losses which take place in the process of storing electric energy and the several processes involved in the conversion. The discouraging figures as regards the weight were based on the assumption that secondary batteries attained their highest grade of capacity several years ago, when they were first introduced. No account was taken of the fact that the enormous energy of 360,000 foot pounds was contained in one pound weight of oxidised lead, and that there was a great margin left for improvement. It is doubtful whether much further progress can be made in the lead accumulator of the present day without sacrificing durability; but secondary batteries have been, and are being successfully applied, for the purposes of electric locomotion, whose weight are by no means prohibitory. Thus, a tramcar furnished with accumulators will only weigh one-fifth more than a car without these adjuncts, or, in other words, the total weight has not to be increased by more than 20 per cent. This is trifling when compared with steam, compressed air, cable or other modes of mechanical haulage. It is not our intention to make comparisons between these different methods of propelling tramcars, but we propose merely to study the points of economy and general efficiency of the electrical systems, and draw comparisons between these and the most popular tramcar motor, the horse.

ELECTRO-MAGNETS IN COMPOUND MACHINES.

IN the so-called compound dynamos, named also, according to a recent suggestion, compensation machines, the iron core receives, as is well known, writes Wilhelm Peukert in *Zeitschrift für Electrotechnik*, two wrappings. The one with the thicker wire is introduced into the main circuit, whilst the other of thinner wire forms either a by-circuit of the armature or of the outer circuit. In such machines, consequently, the iron cores are magnetically excited by two magnetising forces, and the question as to the total magnetism resulting under such circumstances has therefore acquired an especial practical importance.

Dr. O. Frölich gives, in one of his most recent treatises (*Elektrotechn. Anzeiger*, 1885, No. 15), a formula which allows of the calculation of the magnetism resulting from two given magnetising components. If, with him, we call the degrees of magnetic saturation produced by the two windings (each supposed to act singly), M_1 and M_2, Frölich's formula

$$1 - M = \frac{(1 - M_1)\,(1 - M_2)}{1 - M_1\,M_2} \qquad (1.)$$

is applicable for the magnetism resulting from the simultaneous action of both windings. This relation follows naturally from the relation given by Frölich between the magnetism, M, and the strength of the current, J, that is from the equation

$$M = \frac{m\,J}{1 + m\,J},$$

in which m is a value depending on the windings of the limbs.

Dr. Frölich, when stating this formula (1), gives no results which might serve as an experimental confirmation. I had recently the opportunity of carrying out some experiments with this purpose in order to determine experimentally the total magnetism produced in an iron core by two magnetising forces acting simultaneously, both in the case when the two magnetic components support each other, and when they act in mutual opposition. I may here premise that the results obtained fully agree with Frölich's formula.

The experiments were conducted with a magnet limb of a compound machine which had been most obligingly placed at the disposal of the Electrotechnical Institution by the firm Kremenezky and Mayer, of Vienna.

The electro-magnet, the cylindrical iron core of which had a diameter of 10 centimetres and a length of 35·6 centimetres, had two windings. The inner one had with 45 double turns of a wire 3·64 millimetres in thickness (measured with its double coating) 6 layers, each of 90 turns, or, in all, 540 turns. The outer one consisted of 14 layers, each of 200 turns of a wire 1·66 millimetres in thickness. The degrees of magnetic saturation attained are represented by the quotients of the temporary magnetic moments actually obtained for the different strengths of the current and the maximum moment of the iron core. For calculating the latter the absolute unit of Waltenhofen were assumed to be 212·5 per unit of weight (Gramme), so that the resulting value was 4633·000.

The determination of the temporary moments in absolute measurement was effected by deflection experiments in which the electro-magnet was placed opposite to a short declination-needle in the so-called first main position. In the more feeble magnetic moments the electro-magnet acted upon a magnetic needle, 1·8 centimetre in length, whose axis of rotation was at a distance of 144·8 centimetres from the middle of the iron core. In experiments with stronger moments the deflections were read off on a needle 2·5 centimetres in length, placed at a distance of 299·3 centimetres from the middle of the electro-magnet. Both needles were provided with aluminium pointers, which moved over corresponding graduated scales. On account of the distances off of the needles being considerable as compared with their length a correction on account of length was superfluous in calculating the results. The magnetic moments of the coils were calculated from the total surfaces of all the turns (for which the values 63·583 and 616·470 were found) by multiplying by the strength of the current in absolute units, and deducting the result from the total moment. If we call this M, and the moment of the spirals m, we have for the moment of the iron core $M_0 = M - m$, for which, if we express M and m in the ordinary manner, we may write:

$$M_0 = \frac{a^3 H}{2} \cdot \tan. \alpha - J \Sigma F .$$

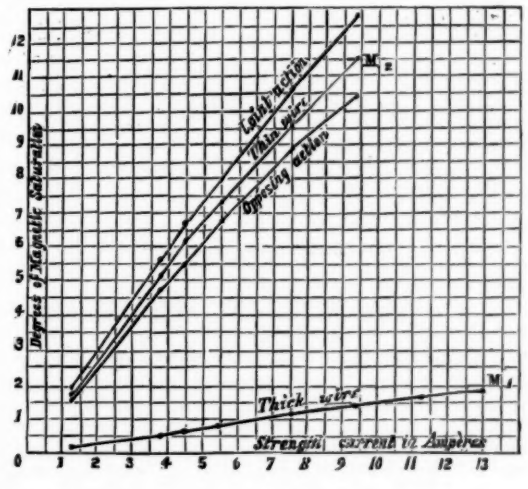
Here a is the distance of the needle from the middle of the iron core, H the horizontal intensity of terrestrial magnetism, and α the angle of deflection of the needle.

If we call the maximum moment M, the proportion $\frac{M_0}{M}$ gives the degree of saturation obtained.

The current was furnished by a Schuckert's compound dynamo, which could be brought up to the yield required, on every occasion, by rheostats introduced into the circuit, a sufficient selection of which was at hand. The strength of the current was measured by means of a Gaugain tangent galvanometer made by Siemens and Halske with the use of the ring, for which I determined the factor of reduction by means of a copper voltameter as 4·20. The readings on the galvanometer were undertaken by the assistant K. Zickler, to whom I express my best thanks. For each strength of the current at least six readings were taken (varying the direction of the current), and the mean values thus obtained were used as the basis of the further calculations. The results are given in the following table.

Number.	Strength of current in ampères.	Magnetic moments.		Degrees of saturation.		Joint action.			Opposed action.		
						Moments.	Degrees of saturation.		Moments.	Degrees of saturation.	
		Thick wire.	Thin wire.	M_1	M_2		Determined by experiment.	Calculated.		Determined by experiment.	Calculated.
1	0·436	17·620	168·864	0·0038	0·0364	189·522	0·0409	0·0399	151·530	0·0329	0·0328
2	1·243	51·886	477·534	0·0112	0·1031	527·945	0·1139	0·1127	436·673	0·0943	0·0935
3	1·492	63·626	584·512	0·0137	0·1262	625·393	0·1349	0·1366	518·654	0·1119	0·1157
4	1·817	74·200	691·991	0·0160	0·1494	751·996	0·1623	0·1611	629·671	0·1358	0·1377
5	2·498	104·152	890·122	0·0225	0·1921	985·324	0·2127	0·2069	827·871	0·1786	0·1775
6	3·133	129·186	1067·395	0·0281	0·2304	1179·994	0·2547	0·2471	970·096	0·2093	0·2139
7	3·768	154·442	.....	0·0333							
8	4·349	177·623	.....	0·0383							

The degrees of saturation given in the table as calculated, have been worked out according to Frölich's formula, as given above, and agree very well with the experimental results. When using the thin wire a current strength of three ampères could not be exceeded on account of the considerable heating of the wire. Hence the experiments 7 and 8 with this combination were omitted.



The accompanying diagram shows the connection between the strength of the current and the degrees of saturation reached. The strengths of the current are plotted out on the abscissal axis, and the degrees of saturation as ordinates. The curves thus obtained display, even at these degrees of saturation, a concavity towards the abscissal axis, a noteworthy fact, since according to this relation the proportionality of the degree of saturation to the strength of the current in thick rods is confined within much narrower limits

than is universally assumed, since according to the electro-magnetic researches of Dr. A. von Waltenhofen, conducted with thinner rods, the proportionality has been found to extend up to degrees of saturation of 40 to 50 per cent.

The magnetic moments laid down in the table induce me to mention a formula for their calculation from the dimensions of the rods, which Dr. A. von Waltenhofen has given in his latest memoir (*Zeitschrift für Elektrotechnik*, 1886, p. 2). If we call the respective length and thickness of the iron core in centimetres l and d, the total number of turns of the winding, n, and the strength of the magnetising current, i, then according to Waltenhofen's formula the magnetic moment reached is

$$y = 0{\cdot}69\, l^{1{\cdot}6} \,.\, d^{0{\cdot}7} \,.\, n\, i$$

Dr. A. von Waltenhofen mentions in the same place experiments which verify the formula within very extended limits. As a further confirmation of the formula may serve, the following table in which the values calculated according to the formula are placed in juxtaposition with those observed.

MAGNETIC MOMENTS.

Observed.	Calculated.	Observed.	Calculated.
17·620	16·270	168·864	168·723
51·886	45·925	477·534	476·641
63·626	55·169	584·512	572·123
74·200	67·150	691·991	696·747
104·152	92·367	890·122	957·884
129·186	115·810	1067·395	1201·380
154·442	139·327		
177·633	160·774		

Within the limits of proportionality (for which the formula is only applicable) the observed and the calculated values agree very well, especially those produced by the thin wire, since here there are only discrepancies of two per cent. For the thick wire there certainly occur more considerable differences which, however, extend to 13 per cent. in one case only, and which are probably due not to the formula but to the circumstance that between the double turns of this wrapping there existed certain inequalities which could not be taken into account in the calculation. But even if these differences do not depend on the circumstance mentioned but on the formula, it still remains very valuable, the more, if we consider that hitherto we were not in a position to carry out such calculations even approximately and within wide limits.

Finally, I must claim permission to express my gratitude to Dr. A. von Waltenhofen, President of the Electro-technical Institute, who has courteously afforded me the facilities for carrying out these researches.

PNEUMATIC TELEGRAPH TUBES.

IN a recent number of the ELECTRICAL REVIEW I noticed that some enterprising gentleman had devised a system of pneumatic tubes, combined with electric appliances, by which telegrams, letters, &c., could be transported. Since but little has been published upon postal or telegraphic pneumatic transmission, I trust that the following brief description of the pneumatic telegraph tubes used in this country may not prove without interest.

The pneumatic tubes used in Great Britain are made of lead, and when laid beneath the streets they are enclosed in iron pipes for protection. The tubes vary in length from two miles downwards, the average length being about $\frac{3}{4}$ mile. The diameter of the longer and more important tubes is 3 inches, and that of the shorter and less important tubes $2\frac{1}{4}$ inches. The carriers within which the messages are sent through the tubes are made of gutta percha tubing, covered with felt, and have a head of several pieces of felt which accurately fits the tube. The carriers used with the 3 inch tubes weigh about 7 ozs., and will contain about 36 messages; those used with the $2\frac{1}{4}$ inch tubes weigh about $2\frac{3}{4}$ ozs., and will contain about 12 messages.

Each of the tubes is provided with a simple electrical contrivance by which the departure from and the arrival at each station of the carriers is signalled.

The power by which these tubes are worked is derived from steam engines located at the central office. These engines work air pumps which either take air from the atmosphere and compress it to a smaller volume and then discharge it into the pressure main, whence it is admitted by means of taps into the different tubes when carriers are despatched to an out-station; or the pumps take air from the vacuum main, compress it to the atmospheric pressure and then discharge it into the atmosphere; the air in the vacuum main is, of course, being continually renewed by the air which flows from the atmosphere through the tubes into the vacuum mains during the transit of the carriers from the out-stations.

The velocity with which the carriers travel is usually between $\frac{1}{3}$ and $\frac{1}{2}$ a mile per minute. The approximate time of transit in minutes through a tube of L miles = $2{\cdot}7\ L^{\frac{3}{2}}$ with the $2\frac{1}{4}$ inch tube, and $2{\cdot}1\ L^{\frac{3}{2}}$ with the 3 inch tube.

The energy expended in driving a carrier from the central office to an out-station is equal to the volume of compressed air which flows into the tube during the transit multiplied by the work required to produce a unit volume of compressed air.

The volume of compressed air which flows into the tube during transit is equal to about $\frac{6}{7}$ of the tube's cubical capacity. The capacities of the $2\frac{1}{4}$ and 3 inch tubes are 146 and 251 cubic feet per mile respectively, so that the volumes of compressed air used in driving a carrier through a mile of each tube are 125 and 200 cubic feet respectively.

The work required to produce a cubic foot of compressed air at a pressure p_1 from a pressure p_0, lies between the isothermal value

$$\cdot 01005\ p_1 \log. \frac{p_1}{p_0} \text{ horse-power minutes.} \quad (1)$$

and the adiabatical value

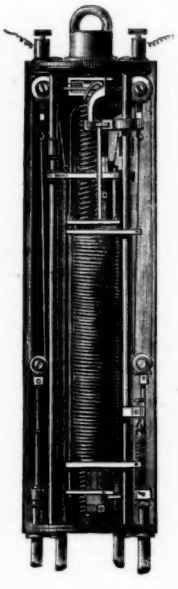
$$\cdot 01505\ p_1 \left\{ \left(\frac{p_1}{p_0}\right)^{\cdot 29} - 1 \right\} \text{ horse-power minutes.} \quad (2)$$

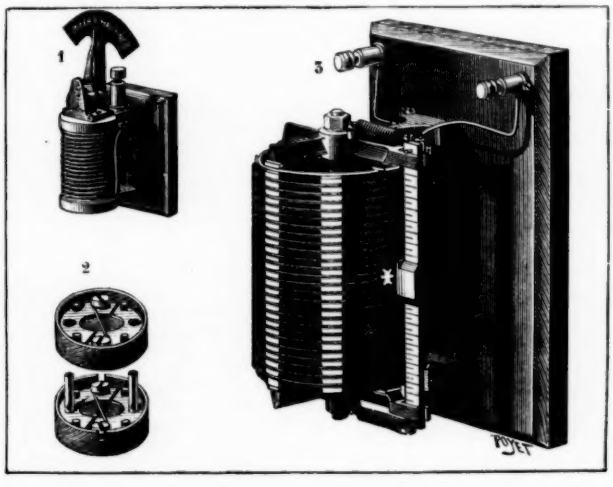
So that to produce a cubic foot of compressed air at a pressure of 12 pounds to the square inch above the atmospheric pressure would require between ·0695 and ·0755 nett horse-power minutes, or say about ·085 gross horse-power minutes; and, therefore, the energy expended in driving a carrier through a mile of the $2\frac{1}{4}$ and 3 inch tubes would be 10·6 and 17 horse-power minutes respectively.

When a carrier is despatched from an out-station to the central office, the air in the tube first expands into the vacuum main and thence into the pumps, where it is compressed to the atmospheric pressure and then discharged into the atmosphere. By the aid of formulæ (1) and (2) it is found that the gross amount of work of ·065 horse-power minutes is required to pump a cubic foot of air into the atmosphere from a vacuum main at a pressure of 8 pounds per square inch below the atmospheric pressure. If the tube has been at rest immediately before the carrier is despatched to the central office, the volume of air which will be pumped into the atmosphere from the vacuum mains will be equal to the cubical capacity of the tube; and therefore the energy expended in the transmission of the carrier would be 8 and 13 horse-power minutes with the $2\frac{1}{4}$ and 3 inch tubes respectively. If, however, the tube had immediately previously been used to receive a carrier from an out-station, there would be a partial vacuum in the tube, and therefore the expenditure of energy would be less, say $6\frac{1}{2}$ and $10\frac{1}{2}$ horse-power minutes respectively. But if, on the other hand, the

tube had just previously been used to despatch a carrier to an out-station, it would be partially filled with compressed air; and the amount of work which the pumps would have to perform would be greater, and the amount of energy expended during the transit of the carrier would be about 12 and 19 horse-power minutes with the $2\frac{1}{4}$ and 3 inch tubes respectively.

These amounts of energy would be expended in several different forms. Firstly, work would be performed in pushing back the atmosphere at that end of the tube at which the pressure was lowest; secondly, energy would be expended in generating mechanical vibrations of the tube; and, thirdly, in overcoming the friction of the carrier within the tube. The first of these quantities is much the greatest, and is equal to about $\frac{3}{4}$ the net work of the engine in pressure working, or about $\frac{2}{3}$ the net work of the engine in vacuum working.





The energy expended in overcoming the friction of the carrier may be approximately calculated from the formula

$$\frac{W\ L}{150} \text{ horse-power minutes,}$$

where W is the weight of the carrier in ounces and L length of tube in miles.

Thus, with the $2\frac{1}{4}$ inch tube, the energy expended in overcoming the friction of the carrier through a mile of tube would be about $\frac{1}{30}$ horse-power minute, or with the 3 inch tube about $\frac{1}{20}$ horse-power minute. So that the energy expended in overcoming the friction of the carrier itself would be only $\frac{1}{2000}$ to $\frac{1}{6000}$ of that expended in expelling the air from the tube.

The expenditure of energy in the transport of a pneumatic carrier is enormous as compared with other methods of transportation. Thus with the same expenditure of energy a locomotive will transport as many tons upon a railway as a pneumatic tube will transport ounces. The use of pneumatic tubes for transport purposes is indeed so wasteful of energy that it has completely failed to be practicable, except in pneumatic telegraph transmission; and it is possible that even for telegraphic purposes pneumatic tubes may be ultimately superseded by some more economical system.

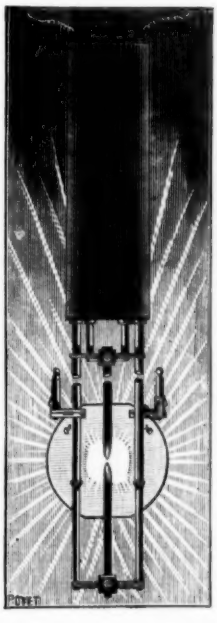
W. MOON.

The "Palace of Delight."—The Governors of the Salt Schools, Saltaire, have resolved, in consequence of the delay in the building operations caused by the prolonged frost, to defer the opening of the Palace of Delight until May 3rd, 1887.

THE LIGHTING OF THE ELDORADO.

AMONGST the recent installations in Paris one of the most noteworthy is certainly that of the Eldorado Café and Theatre. The results obtained, the steadiness of the light, and its uniform distribution, even on the stage, and all the advantages of the electric light—absence of heat and smell, the preservation of the decorations, &c.—prove once more, states a writer in *La Nature*, that electric lighting is eminently practical and that the electric light really is the light of the future.

For reasons into which we need not enter here, the installation has been made without any reserve apparatus, therefore an accident, or mischance, happening to any part whatever of this installation would necessarily cause a complete stoppage; it is, therefore, most risky to light a theatre under such conditions,



but up to the present the experiment has been crowned with success.

The steam is supplied by a Collet tubular boiler; the steam engine, which is horizontal, with a single cylinder, was constructed by Messrs. Orly and Granddemange. It actuates two groups of Gramme machines (workshop type) excited in derivation and constructed by the firm of Ducommun.

Each machine feeds five Cancé lamps grouped in parallel at the terminals of the dynamo, *i.e.*, each of them has its distinct circuit. This is evidently not an economical method, or one applicable to large areas, but it ensures the absolute independence of each group, which, in the particular case of a public building, and especially a theatre, is of primary importance, for the working of each lamp can be regulated from the engine room. To effect this, on the circuit of each is placed a regulating apparatus, which protects it against any abnormal excess of current. Each lamp is furnished with a fusible leaden wire, which serves to break the circuit and which has this advantage, that, when one of these wires is melted it can be replaced by another, so that the extinction lasts but a very short time.

The breaking of this wire ought only to take place in a case impossible to avoid, for a current indicator gives with sufficient exactness at every moment the intensity of each lamp, which value can be corrected by the aid of a metallic rheostat of German silver wire, the resistance of which can be altered without interrupting the current.

A special arrangement of double commutator for two directions has been added to enable a single spare machine to be substituted, at will, for any one of the dynamos of the installation, in case any interruption

should occur during the working; it is thus possible to provide against accident to any one of the electrical machines.

The most original and remarkable feature in this installation is certainly the lighting of the footlights. Rejecting the methods adopted and applied up to that time, *i.e.*, instead of having a large number of lights of low intensity, M. Cancé has employed arc lights; in this particular case they are six in number, three on each side. It was indispensable to arrange them so that the distribution of the light should be uniform, and to avoid shadows being cast upon the stage, which would have been highly objectionable. In order to effect this the lights are enclosed in a rectangular box, the sides of which, being painted white, reflect the luminous rays in all directions, and give them out in the form of a sheaf with a vertical axis. By the aid of reflectors the rays which by these reflections would be directed into the hall are concentrated upon the stage; and, in order that the lights may not be so dazzling as to incommode the actors, the rays pass through opal globes. In order to obtain stage effects, masses of colour, twilight or comparative darkness, a series of curtains of different colours and thicknesses can be drawn before the glass, and so produce either suddenly or gradually the effect required. When complete darkness is required the stage lights and footlights are extinguished, but an equivalent resistance is substituted for them so as not to affect the working of the machinery.

M. Cancé has contrived a special rheostat in which the resistance consists of a liquid mass to which the current is conveyed by a series of metallic plates which are entirely immersed. By causing the surfaces directly opposite one another to vary, the liquid resistance interposed between the two series of electrodes is changed.

This apparatus has the advantage of being very easily regulated continuously, and there is also less fear of its getting heated than with the metallic spirals of the ordinary rheostats. Having described all the details of the working of the apparatus, we will conclude by giving a description of the lamp employed in this installation. It has a fixed luminous point and is mounted in derivation, consequently the regulating solenoids are in the circuit. The two carbons are held by two cross bars united by cords, running in such a manner on the return pulleys that the lower (negative) carbon is shifted at half the rate of the upper carbon, which is positive. The regulation is effected by acting on the upper carbon holder; it is connected with a screw nut which passes into a screw movable only round its axis. A brake actuated by the solenoids works upon the screw. If the pressure is strong enough to hinder it from turning the screw remains fixed and the carbons keep the same distance apart; if the solenoids act with less force, *i.e.*, if the arc increases beyond a certain limit the brake acts, the screw turns and the carbons are brought nearer together, and thus the arc is restored to its normal length. The regulation acts surely and without jerks; the working is thus regular, and consequently the light is steady and without any appreciable variation as long as the current which feeds it remains constant.

The regular working, the quality of the light, and, above all, the ingenious contrivances designed and applied by M. Cancé render this installation of the electric light, the mechanical importance of which is comparatively slight, certainly one of the most remarkable in Paris.

The Light at Hell Gate.—Pilots have grumbled a great deal of late, says the *Electrical World* of the 6th inst., when going through Hell Gate after dark. For the last twelve days that neighbourhood has been shrouded with general gloom, no electric light illuminating its tortuous channels, the engines and boilers being shut down for repairs. The light will shine forth again in a week or two.

THE PRODUCTION OF ALUMINUM AND ITS ALLOYS IN THE ELECTRIC FURNACE.*

By EUGENE H. COWLES.

In order that I may give you as brief and explicit an explanation as possible of our discovery, process and inventions, I will first proceed with a description of the plant of the Cowles Electric Smelting and Aluminum Company, now in operation at the works of the Brush Electric Company, at Cleveland, O.

The apparatus used by us for the purpose of experiment in the reduction of refractory ores for the production of metallic calcium, magnesium, potassium, sodium, silicon, titanium, and the manufacture of aluminum and aluminum-bronze and other alloys consists of two large Brush dynamos, two resistance boxes and two ammeters, a drying pan, eight fire-brick furnaces, suitable electrical conductors and switches, hoods for carrying off vapour and gases, large carbons—3 by 30 inches—for electrodes, screens for sizing charcoal and carbon, and a large mortar and pestle and several washing vats for washing and concentrating the furnace products. Steam power to drive the dynamos is furnished by the Brush Electric Company. The arrangement of the plant so as to effect the reduction of the above-named metals and metaloids, by means of carbon as the sole re-agent, is as follows:

The Dynamos.—These are, of course, placed in the dynamo room as near as possible to the driving shaft, where they can be kept free from any dust or grit from the furnace room. The larger of these is by far the most powerful machine ever built by the Brush Electric Company. It weighs over 7,000 pounds, and at a speed of 907 revolutions per minute produces a current of 1,575 ampères with an intensity of 46·7 volts. It is of the shunt-wound shape of dynamo, built for the purpose of incandescent lighting; further than being of greater capacity, and having a hub made of the Cowles aluminum-brass which exhibited a tensile strength of 95,000 pounds per square inch and 5 per cent. elongation, this dynamo does not differ from the ordinary machine.

Conduction of the Current of the Large Dynamo to the furnace in the furnace room and back to the machine, is accomplished by a complete metallic circuit except where it is broken by the interposition of carbon electrodes, and the mass of pulverised carbon in which the decomposition of the ore takes place. This circuit consists of thirteen copper wires each 0·3 inches in diameter. There is likewise inserted into this circuit an ampèremeter through whose helix the entire current flows, indicating, by its suction of a plunger armature attached to a spring balance and dial-faced indicator, the total strength of current being used.

This ampèremeter is an important element in the management of the furnace, as by the position of the finger on the dial the furnace attendant can tell to a nicety what is being done by the current within the furnace. It is placed upon a shelf in a good light, near to and in full view of a person in any position about the furnace.

Between the ammeter and the furnace in the furnace room, and forming part of the circuit, is placed a large resistance coil of German silver immersed in water, a heavy copper slide passing backward or forwards as desired, throwing more or less of this resistance into the circuit, and almost the entire energy of the current may be thus applied to heating water. The object of the resistance box is to serve as a safety appliance. It is used by the furnace operator when it is desired to change the current from one furnace to another, or if it be necessary to choke off the current almost entirely before breaking it by a switch, thus preventing serious flashing at the commutator of the dynamo or at the switch. It is likewise of value should any evidence of a short circuit appear in the furnace or elsewhere.

Thus far the apparatus that has been described, presents no novel feature beyond its great magnitude, the peculiar combination made, and the purpose for which it is used. Now, however, we will describe a device that we claim is something radically different from anything that has heretofore been known, namely an incandescent electrical furnace for the smelting of refractory ores, metals and compounds, and in which other metallurgical and chemical operations, impossible in the past, may now be performed with both ease and economy. This furnace as constructed to utilise the current of the large dynamo, is a rectangular oblong box of fire-brick, with walls, bottom and ends, 9 inches thick. The interior space being 5 feet long by 1 foot wide and 1 foot deep. This is closed by a cast iron slab or cover through which are two 3-inch holes for the escape of the gases liberated during the operation. This lid may be removed at will, its own weight being all that is required to keep it in place. The walls of the furnace are designed to be air-tight. At both ends of the furnace are holes large enough to admit an enormous electric light carbon, 3 inches in diameter and 30 inches long. Each of these carbons is connected at the end, projecting outside of the furnace, with the positive or negative conductor as the case may be, the connection being a copper cap fitting over the end of the electrode, the same being fastened to a large and flexible wire cable which forms part of the circuit. When it is desired to charge the furnace, it is first necessary to lime it, to prevent its destruction by heat. To do this, a quantity of finely pulverised charcoal that has been soaked in a solution of lime and water, and then thoroughly dried in the drying pan, is put into the fire-brick

* Read at a meeting of the Franklin Institute, January 20th, 1886.

box, enough being placed therein to cover the floor to a depth of several inches. The carbon electrodes are then pushed into the box through the end walls until the ends of the carbons are but a few inches apart. These electrodes are just on top of the finely powdered charcoal of the floor. A sheet iron gauge or guard, parallelogram shaped, and open at top and bottom, is now placed over these electrodes in such a manner as to form two walls on either side of the electrodes about three inches distant. Space is thus left between the sheet iron and the walls of the furnace, and likewise for about a foot at each end of the same. More finely powdered limed charcoal is put into the furnace box so as to completely fill the space outside the sheet iron gauge and within the furnace walls and up to within a couple of inches of the top. The furnace is now almost entirely full of the lime washed charcoal, except the space 9 inches wide, 3 feet long and 6 inches deep in the centre of the box, and into which the electrodes project. All is now ready for the charge, which is prepared. Should it be desired to produce aluminum bronze, we mix 16 or 18 pounds of granulated copper, 12 to 14 pounds of aluminum oxide in the form of broken corundum, and several pounds of coarsely broken charcoal together, and burying the electrodes with the same, and thus filling the space inside the walls of the sheet iron gauge. The gauge is then lifted from the furnace, additional coarse charcoal is spread over the entire mass, the iron top of box is put in place, the seams luted with fire clay, the current from the dynamo switched on, and the furnace is in operation in but little more time than it has taken to give these apparently trifling but very important details.

We will now proceed to make a little study of the philosophy of the process, after first watching a successful "run" or "heat" from the beginning to the close of the operation. Of course, the furnace and its contents, when the current of electricity was turned on, were entirely cold and the resistance presented to the flow of the current consequently is higher than it would be at any time during the "heat," unless some unforeseen accident, such as a slight explosion of gas, takes place. But notwithstanding that the furnace is cold, a complete metallic circuit, with carbon tips dangerously near together, is ready to convey a 100 horse-power flash of lightning into the furnace, should a short circuit occur. *There are likewise many pounds of pure copper in between and about these carbon tips that may be melted and run together and thus produce a short circuit. With these conditions an electrician would insist that the man in charge of the furnace should look pretty sharply lest the four thousand dollar dynamo at the other end of the wire be burned out, or somebody be injured by a heavy flash.* The man in charge, however, has anticipated such a contingency by having thrown in several coils of the resistance box, so that under no condition, even if the great carbons in the furnace were pressed tight together, would the dynamo be able to produce a current of more than 1,600 ampères, the maximum load. Upon watching the ampèremeter, however, it is seen that this precaution was not necessary for only about 200 ampères are indicated as flowing, the artificial resistance is therefore slightly diminished, the needle of the ammeter moves up rapidly to 600 or 800 ampères, suddenly it gives a jump up to 1,200, then back to 200, then with a bang the armature of the ammeter is brought against the magnet and it registers 1,600 ampères of current flowing, and then instantly drops back to almost zero.

As every jump of that needle means wear and tear on the commutator and brushes of the dynamo, care is now taken to keep more control of the current and a little more artificial resistance is thrown into the circuit. The needle now moves more slowly around the dial, gradually making fewer and fewer jumps, and at the end of eight or ten minutes it has worked up to the 1,000 ampère mark, and becomes quite steady. Suddenly there is a hiss and a sharp report, a tongue of greenish yellow copper flame darts upwards from the hole in the furnace top and then disappears, to be followed after a minute or so by a slight vapour. This was caused by the monoxide of carbon combining with the atmosphere in the furnace to produce an explosive compound. To prevent this gas from accumulating to an extent to raise the furnace top and loosen the luting, the attendant holds a lighted stick over the vent and a series of slight explosions follow.

Soon a characteristic yellow-white flame appears above the hole, the needle registers about 1,200 ampères of current flowing, all of the artificial resistance is withdrawn, and the process of reducing aluminum and alloying it directly with copper is completely under way. Soon the needle gradually creeps around the dial to the 1,400 or 1,500 ampère mark. This is regarded as being a little too hot work for the dynamo, and at the same time the plume of flame above the furnace indicates a little less rapid reduction. There are, therefore, two things now necessary. The first is to put more resistance into the circuit, and the second is to put more ore into the zone of reduction. These are both done by withdrawing one of the electrodes and the ammeter needle drops back to 1,200, and the flame above the furnace soon gives evidence of doing more work, by reason of more copious white fumes being given off.

This pulling out of the electrodes is repeated over and over again until both are out to their full length. At the end of an hour the "heat" is completed. The current is then switched to another furnace, but one furnace being used at a heat. The artificial resistance is again resorted to, enough being thrown into the circuit gradually, thus slowly choking off the current, permitting the proper regulation of the brushes on the dynamo, and also giving time for the engine to govern itself. Finally, at the end of several minutes, the switch is thrown open and the furnace is entirely out of the circuit. Furnace No. 2 is now operated in precisely the same manner as the furnace No. 1, which is allowed to cool off. At the end of two hours furnace No. 2 is thrown out of the circuit and work begun on furnace No. 3. By this time No. 1 is ready to be discharged. The lid is removed, and water is used with a sprinkling pot to quench the fire still remaining. At the bottom of the furnace, on the floor of fine charcoal, is found an oblong metallic and crystalline mass of white metal. It is the copper charged with from 15 to 35 per cent. of aluminum and a small quantity of silicon. It frequently averages 20 per cent. to 22 per cent. of aluminum and silicon. Covering this mass is also found a considerable quantity of fused carbide of aluminum. Analysis of this product has shown 30 to 60 per cent, of metallic aluminum present. On cooling, it forms very large and distinct crystals.

The very rich white bronze is collected together, put into an ordinary graphite crucible, and run into ingots weiging 50 or 60 pounds. These are carefully analysed by the chemist, after which they are remelted and copper is added to them in the proper proportion to reduce them to the standard 10 per cent. aluminum bronze. To guard against mistakes being made in the analysis of the white and brittle ingots in the amount of copper added thereto, and in keeping the bronze free from impurity, every ingot of 10 per cent. aluminum bronze has its tensile strength tested, and it must show a tenacity of at least 90,000 pounds to the square inch.

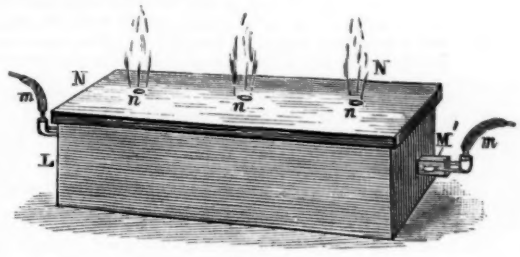


FIG. 1.

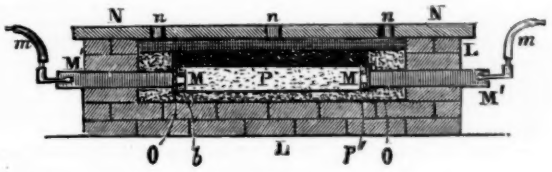


FIG. 2.

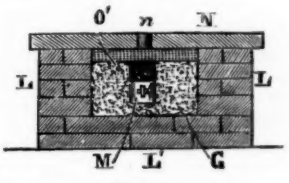


FIG. 3.

L L'. Fire-brick floor and walls. N. Removable fire-clay cover. n. Vents for escaping gases. M M'. Electrodes. m. Conducting wires to dynamos. O. Packing of fine charcoal. P. Charge of ore and granular charcoal. O'. Layer of granular charcoal, covering charge on top.

As to the capacity of our large dynamo, and the economy of the process, a few figures may be interesting. In ordinary circumstances we expect to average a daily production of at least 300 pounds of 10 per cent. aluminum bronze for 20 hours' work with each machine of this size. In addition to this 300 pounds of bronze, containing in round numbers 30 pounds of aluminum, there is produced about 60 pounds of metallic aluminum in the bye-products, a large portion of which, with proper concentrating apparatus, will be cheaply reclaimed and rendered marketable. Ninety pounds of aluminum in 20 hours is a production of four and one-half pounds per hour. Four and one-half pounds per hour produced by the energy of 120 horse-power equals the consumption of about 26·6 horse-power per hour to reduce one pound of aluminum. At times we have far exceeded this result. Indeed, two heats have been made wherein the energy consumed has been but twelve and one-half horse-power per hour per pound of metallic aluminum produced. Theoretically it should consume only about four and one-half horse-power per hour to effect the reduction, and in a new form of compound furnace to be built at our Lockport works, and in which 1,000 horse-power will be consumed, it is confidently expected that the output of bronze will not consume more than 15 to 20 horse-power per hour for the reduction of one pound of aluminum.

Economy of the Process.—This may best be judged by the public in a general way from the fact that we are selling our 10 per cent. aluminum bronze as low in some instances as 45 cents per pound net, and we are not selling it at a loss financially. This same bronze cannot be purchased elsewhere for less than $1.30 per pound. Our list price on 10 per cent. bronze is 60 cents per pound.

The two and one-half per cent, five per cent. and seven and one-half per cent. bronzes are all proportionately less in cost. By the addition of zinc to the lower grades of aluminum bronze an aluminum brass is produced which is at once tough and malleable and of at least three times the tensile strength of ordinary brass. This brass has also vastly superior power to resist corrosion and oxidization. It can be made from the aluminum bronze at a total cost of 18 or 20 cents per pound.

Value of Electric Smelting.—The Cowles Electric Smelting and Aluminum Company claims that its process of electric smelting, within the next five or ten years, is destined to as completely revolutionise the brass and bronze trade of the world as the Bessemer converter has the iron and steel industry. This claim is based simply upon the ease and cheapness by which it can produce the alloys of aluminum and silicon, and the vast superiority of these alloys over any composition now in the market. It is further believed that cheap aluminum bronze means a new era in warfare; that it insures a return to the age of bronze in the matter of heavy cannon, armour plates, gun carriages and small firearms. Why aluminum bronze is the best metal for heavy guns is because sound, reliable and malleable castings can be made of at least 50 tons tensile strength per square inch, an endurance that far exceeds that of any forged iron or steel when made into heavy guns, and a finished gun of this kind can probably be manufactured in one-quarter of the time and at far less cost of one made of steel. Heavy pieces of steel ordnance now cost from 75 cents to $1 per pound, require a vast plant for their production and a very long time for completion. The same guns made from aluminum bronze could be cast in an ordinary foundry of sufficient capacity and finished in a lathe, thus avoiding all forging, welding, shrinking on of rings, tempering, drilling, and annealing now required in the manipulation of heavy steel and iron cannons. Armour plates for heavy fortifications and ships could be made completely from cast metal, no machine work being required to finish them ready to go into place.

For cartridges, we believe that sheet aluminum bronze will prove to be unrivalled by any composition now known, for it is the only cheap metal not affected chemically by gunpowder, and that in turn does not deteriorate the gunpowder when stored for a period of years. It is so strong, and so much less in specific gravity than brass or copper, that the cartridge shell may be made of one-half the weight now required. Aluminum bronze is likewise most admirably adapted, on account of its enormous tenacity and stiffness and resistance to all forms of corrosion, for torpedo boat cylinders and steam boilers, seamless tubes, stay bolts, and particularly rivets, where great strength is required and there is any tendency to shear off the heads, for it is as easy to obtain 50 tons tensile strength in an aluminum bronze rivet as it is 25 tons in iron.

The Future of the Process is one of great promise, and will undoubtedly lead to the production of cheap and pure aluminum itself within a very brief period.* Indeed, the Cowles Electric Smelting Company asserts, on the back page of its pamphlet, that it expects to put the pure metal on the market within a year. When you are informed that we can charge iron, manganese, tin, copper, nickel, &c., with a very high percentage of metallic aluminum in this furnace, and that, also, without any base metal in the furnace, we can saturate the charcoal contained therein with metallic aluminum, most of which will be in a state of mechanical mixture with the carbon; and further, that we have produced specimens of aluminum 99 per cent. pure in at least three different methods by the electric furnace; and that notwithstanding all this we have not made much of an effort in this direction, the majority of you will agree that the great problem of producing pure and cheap aluminum is practically solved. How cheap this method will be you may judge from the fact that, at our Lockport works, which will have a capacity of only two or three tons per day, we expect to produce the aluminum in bronze with the little silicon contained in it at a cost not to exceed 40 cents per pound, or with copper at 12 cents per pound, the bronze will really cost but about 15 cents per pound.

In truth, "The Cowles Electric Smelting and Aluminum Company" is founded upon the faith that ere long we shall be marketing pure aluminum at a cost not exceeding 50 or 60 cents. per pound. An appreciation of how cheap this would be, can be had from the fact that one pound of aluminum would go about as far as three and one-half of copper, it being that much more bulky, and in reality it would be about as cheap as copper at 18 cents. per pound, without counting its vast superiority over copper for many purposes on account of its greater lightness and resistance to corrosive influence.

Thanking you, gentlemen, for your attention, I would respectfully call your attention to a collection of ore, carbon, white bronze, furnace products, specimens of sheet and wire, and other manufactures of aluminum bronze, that I have brought with me for your inspection.

[NOTE.—Since the above paper was filed with the Secretary of the Institute, it was found possible to prolong the length of the "heats" of the furnace to five hours, and increase the charges to over 100 pounds in weight, and during the same week a button of cast aluminum, five ounces in weight, was separated from the matrix of carbon, in which it was reduced by a process so simple and economical, that the production of pure aluminum from its oxide by the agency of heat and carbon only, is now demonstrated beyond all question.—E. H. C.]

* See Note at end.

DISCUSSION.

Mr. THOMAS SHAW: What do you estimate to be the cost of operating with water-power, as compared with steam-power?

Mr. COWLES: Water-power is certainly the cheaper, where it can be had at first cost.

Mr. A. E. OUTERBRIDGE, jun.: Have you any idea, approximately, of the temperature developed in your furnace?

Mr. COWLES: We have no opinion on this point, further than that the temperature is probably as high, or higher, in spots, than that of the arc, because of the fact that the heat is prevented from being wasted or dissipated, owing to the heat-retaining character of the surrounding walls.

Mr. OUTERBRIDGE: Does the metal flow away after reduction?

Mr. COWLES: No; the capillary action of the pulverised charcoal prevented this from taking place, just as fine flour or dust sustains drops of water and prevents them from flowing away."

Mr. SHAW: How often is it necessary to renew the linings of your furnaces?

Mr. COWLES: About once a week.

Prof. W. H. GREENE: Have you succeeded in reducing metallic calcium from its oxide?

Mr. COWLES: Professor Mabery has reported that we have done so, and Professor T. Sterry Hunt, who spent some time with us in Cleveland observing the action of our furnace, witnessed the run or heat in which the reduction was made. We have also reduced metallic boron from boracic acid, and silicon from silicic acid.

Dr. GOLDSCHMIDT: I saw at the meeting of the American Association for the Advancement of Science, two forms of silicon, one consisting of black crystalline particles, and the other greenish in colour. What is the difference between them?

Mr. COWLES: The greenish material we believe to be partially reduced silicon, or a new sub-oxide of silicon, not hitherto observed. Our reasons for this are that it is always found at an intermediate position, between the completely reduced silicon at the top and the fused silica at the bottom.

Mr. OUTERBRIDGE: Do you observe any relation between the percentage of silicon in your alloys and their ductility?

Mr. COWLES: We believe that the small percentage of silicon obtained in the alloys is a benefit to them, by increasing their tensile strength. This is effected by the metallic silicon absorbing any oxygen taken up by the metal in the process of casting, and rising to the surface as silica, thus freeing the metal from such impurity. This is proven by the fact that on European aluminum bronzes, thus far made, have exhibited as high a tensile strength as our bronzes, by as much as 20 per cent. The highest test of an aluminum-bronze casting other than ours, that we know of, is 94,000 pounds per square inch, while a casting of ours, which was tested some two weeks ago at the Washington Navy Yard, by Lieut. Hall, exhibited a tenacity of over 114,000 pounds per square inch, and we can, and frequently do, make to order, metal of 100,000 tensile strengths in castings, while 90,000 pounds tensile strength is our ordinary standard for 10 per cent. bronze; in other words, we let none go out of our works having less than 90,000 strength.

Mr. ——: Why does not the molten metal short circuit the furnace?

Mr. COWLES: One reason for that probably is, that as the metal becomes highly heated its conductivity is greatly diminished; another, possibly, is that the formation of an alloy, such as aluminum bronze, may still further decrease its conductivity, since it is well known that alloys are often higher in resistance than their constituent metals; but above all, the great preventive would be the volatilisation of the metal as soon as any considerable portion of the current started through it, which would cause a boiling of the mass and thus break up any contacts that should be made between the electrodes. At least, whatever may be the true reason, we find that we have had little or no trouble from this cause during the year that we have been in operation.

The SECRETARY: A few comments, Mr. President, on the general bearings of this important subject may not be out of place here, for the benefit of those who may not be familiar with its technical features. The late Sir William Siemens, I believe, was the first to suggest the utilisation of the intense heating effect of the voltaic arc for metallurgical purposes. He carried this suggestion into practical effect, also, by constructing what he termed an "Electric Furnace," and at the Southampton meeting of the British Association, in 1878, he described a series of experiments which he had made with this furnace in melting steel, nickel, platinum and other refractory metals, which demonstrated the enormous heating effects attainable by this means.

It is worthy of note, however, that nowhere in this paper does it appear that he had conceived the idea of using his furnace to effect chemical operations such as the reduction of refractory ores. That this should have escaped the notice of an intellect so keen, and so thoroughly practical in its bent, is quite remarkable. It remained for the Cowles brothers to take this step in advance. They conceived the idea of a metallurgical furnace in which the reducing action of carbon should be greatly reinforced and exalted by the enormous heat of the electric arc. The results which they have succeeded in obtaining, Mr. Cowles has set forth in his most interesting paper, and are visible in the instructive array of specimens which he exhibits before you.

In view of what has been accomplished so early in the history of this invention, it is risking nothing to predict that when its capabilities shall have been fully developed, it must prove of great advantage to the metallurgical arts. Already, it is almost as good as assured, that it has solved the difficult problem

of producing aluminum cheaply, so that we may expect soon to see it taking the leading position in the arts for which its remarkable qualities appear to fit it so eminently, and from which its high cost, as compared with copper, tin and other useful metals, has hitherto debarred it. The extraordinary reducing power of the electric furnace justifies the expectation also, that with its aid, the world may soon be enriched by the gift of many alloys of unknown and remarkable qualities.

The happy conception of the Cowles brothers has armed the metallurgist with a vastly more powerful weapon than he has hitherto commanded, with which he will be able to achieve results heretofore unattainable. I am sure you all join me in offering them the hearty congratulations of this Institute.

At the close of the discussion, the meeting passed a unanimous vote of thanks to Mr. Cowles for his able and interesting address.

SOME POINTS IN ELECTRICAL DISTRIBUTION.

By Prof. GEORGE FORBES.*

WHEN I had the honour, just a year ago, to give a course of Cantor Lectures to this Society, on the distribution of electricity, the subject had not till then been treated in a systematic manner. When I was this year asked to read a paper before the Society, I eagerly availed myself of the opportunity to take up the straggling threads, and say a few words on the subjects which were previously but inadequately treated.

Allow me to remind you that, in my lectures, I described five different ways of laying the mains, each one depending upon a different method of connecting the dynamo machines and lamps. Three of these may be called direct systems, and two indirect. Each system has special advantages when applied in suitable cases, and when an engineer is designing a scheme of distribution he carefully considers the *pros* and *cons* of each system as applied to the special case, and very often he has to go through the whole calculations of the scheme according to several different systems.

The three direct systems are the parallel, series, and parallel-series methods of attaching lamps to the main conductors.† The two indirect systems are with the use of secondary batteries and secondary generators. Each of these systems is capable of being varied in the details of its application, and each is specially applicable to particular cases.

The first or parallel system is generally most suitable for small installations, but the cost of conductors becomes extravagant when the area is extended, except in very special cases. The series system is at present only used for arc lights, sometimes with the insertion of a few glow lamps in parallel to replace an arc lamp.

The third system is admirably suited in every case where the number of lamps in use at any time is constant, and may perhaps be modified so as to be applicable to other cases. Smaller conductors can be used on this system than on the first, and this effects a very great economy.

Having recalled these points to your notice, I need say no more, as I treated these three systems and their modifications very fully in my Cantor Lectures.

I thought I had spoken strongly enough about the enormous cost of the main conductors, and the necessity for selecting that size of conductor which is the most economical. We must not use too small a conductor, for then the waste of energy in heating the conductors would be enormous. Nor must we use too large a conductor, for this means buried capital. We must select that size which balances one cause of loss against the other so as to give the maximum economy.

I find, however, that, while this axiom has been accepted as such in this country, some writers from America still try to uphold the fallacious views which have hitherto been in vogue there. I have noticed more than one criticism from America, by people asserting themselves to be connected in some way with some of the Edison companies, who protest against my statement that the three-wire system effects an economy of copper of only 25 per cent. over a two-wire system. The difference between us is that I start with the *axiom* that we are to use the most economical size of conductor. My critics start with the *assumption* that they shall use a conductor which shall waste exactly 10 per cent. of the energy. In this way they use a conductor which is not the most economical, and they show a saving of 62½ per cent. of copper over the two-wire system, but with a possible extra waste of energy of 62½ per cent. I said in my Cantor Lectures, and I repeat it this evening, that this manipulation of figures may suit American financiers, but it is not electrical engineering.

Before proceeding to discuss the indirect methods of distributing electricity, which is the main point I wish to touch upon to-night, I wish to supplement my remarks on series lighting by a statement of what has been done in the last year. I expressed a hope that more attention might be given to the lighting of houses by glow lamps in series. I further showed that it was only by means of a constant current flowing through glow lamps in series that the regulation of each lamp could possibly be effected on economical principles. This regulation must be accomplished by altering the length of the filament in the lamp. This has never yet been done, but if inventors once realise the importance of the object to be attained, I feel sure that we shall not have long to wait for the solution of the problem. Now I am delighted to be able to inform you that during the past year at least one inventor has been applying himself to the placing of glow lamps in series. Mr. Bernstein, who has paid so much attention to the system of glow lamps, has worked out the problem of using lamps of low pressure and large current in series. He has boldly taken extreme measures, and proposes to use lamps of 6 volts and 10 ampères. And here he has got over a difficulty I referred to in my Cantor Lectures. I said that there was no economical way of preventing a broken lamp from extinguishing all the others on the series. Passing part of the current through a shunt whose resistance is 100 times that of the lamp would be very expensive if we had in use lamps of the ordinary type, but with a lamp whose resistance is a fraction of an ohm, the expense would be trifling. When the lamp breaks, the current in the shunt is increased so as to release a contact which short-circuits both the lamp and the shunt.

I still think, however, that the loss of energy by heat conduction at the terminals, may be very great in lamps of so low a resistance; Mr. Bernstein tells me it is 10 per cent. Still I can well foresee that, even if a very sensible loss of energy occurred, the economy and convenience of using such a system might be amply sufficient to warrant its adoption in many cases.

I congratulate Mr. Bernstein on his work in the past, and would urge him to develop this idea more fully, and I can assure him that I, for one, will give the fullest consideration to the system when preparing the plans for electric light installations.

I should like also to take this opportunity of congratulating other makers of electrical appliances on the advances which have been made since the date of my Cantor Lectures. I should like especially to congratulate Mr. Swan on the improvements he has made in the manufacture of glow lamps; the Messrs. Siemens and Messrs. Crompton on their successful construction of very large dynamos; Messrs. Elwell and Parker on their great improvements in the details of construction of dynamos and motors; and the Electrical Power Storage Company on the continued improvements in their secondary batteries. I would equally congratulate Messrs. Willans and Crompton for the continued improvements in steam-engine governors, for keeping the current from a dynamo or the pressure at any point in the circuit constant; likewise Mr. Ferranti for having brought out an electric current meter which promises to fulfil all the wants of engineers and the public in this direction; and last, but by no means least, Messrs. Woodhouse and Rawson for various new devices which will go far to assist in designing and carrying out many schemes of lighting; and I would specially mention their automatic cut-out, adjustable to any strength of current, which, though not so new as some other devices, has only been brought prominently to my notice during the past year, and whose simplicity and reliability give me great confidence in employing it. I must not fail to include here, as a subject for congratulation, the rising esteem in which secondary generators are held, and the improvements which have been made in their manufacture.

When I add to this list the admirable lamp-holder of Mr. Alfred Swan, Varley's adjustable carbon resistances, and other small but useful accessories, I think you will agree with me that the facilities at the disposal of the engineer for designing a satisfactory scheme of electric lighting, and which have been added to his store during the past year, are very abundant.

About one of these appliances I should like to add a few words.

First, I may say that the Electric Lighting Act was rendered abortive, if for no other reason, simply for the want of an electric current meter which was in all points satisfactory. In the year 1882, a patent was taken out for a meter in which the current passing round an electro-magnet created a field where mercury was placed, which rotated when the current passed through the mercury from the centre to the exterior of the field. If the magnetism be proportional to the current, and the friction be proportional to the square of the velocity, then the number of turns completed in any time is a direct measure of the total quantity of electricity which has flowed through the meter in that time. The marked improvements introduced into this meter by Mr. Ferranti consist in the perfection of the magnetic circuit, and the introduction of an almost frictionless mechanism for correcting the revolutions and showing them on dials like a gas meter.

I have many of these appliances on the table which any members of the audience may examine at the conclusion of the paper.

In referring to my Cantor Lectures, let me make a few remarks about a double Table which I introduced to assist engineers in calculating the size of mains required in any installation. These Tables have been copied into a number of technical journals and books of reference, but in nearly every case there is no word of explanation how to use them. I have found these Tables of such paramount convenience that I think it right to call attention to them once more. The economical size of main depends upon three variable factors—the price of laying down a ton of copper mains, the interest to be charged on the capital sunk in mains, and the value of an electrical horse-power for the number of hours that is to be utilised during the year. My Table is divided into two parts. Look along the line in the second part which relates to the percentage on capital which you propose to use,

C

* A paper read before the Society of Arts, February 19th, 1886.

† In my Cantor Lectures I used the terms multiple arc, series, and multiple series. I prefer the terms now advocated.

until you come to the column relating to that price of copper which you propose to use, and you then find a number printed which we may call the auxiliary number. Now take the first part of the table and look along the line which relates to that value of a year-horse-power which you propose to use, until you find the auxiliary number; the heading of that column of figures tells you the size of main per 1,000 amperes which is most economical to use according to the data you have employed.

I will now remind you of the position in which we were left after a full discussion in the Cantor Lectures of the three direct systems of distribution. The parallel system, or the three-wire system is admirably adapted in cases where the farthest lamp of the district is within two hundred yards of the central station. So soon as you go to greater distances the cost begins to increase in an alarming ratio. Hence this system would be applicable to a large district only by having engines and dynamos put down at a very large number of small stations. Now, a station is not worked economically unless the engine driver and stoker are fully employed, and the maximum economy cannot be reached with less than about 1,000 horse-power. Thus the parallel system is only applicable to cities so densely populated as to have a consumption of about 10,000 16-candle-power lamps in a radius of 200 yards. But in most districts of this class space is valuable, and a large number of such stations would be very expensive. We must, then, in the parallel system of distribution, be content to work at a cost which is above that of the ideal of economy. There are many cases where the great simplicity of such a system does actually make it worth while to sacrifice this ideal of economy, and when an engineer is consulted on such matters, it is his duty to estimate the exact loss from not strictly following the ideal economical rules before adopting or rejecting this system. In order to make a parallel system effective, the central station must use distributing boxes, the methods of placing which are described in my Cantor Lectures.

The cure for all these evils would be found if a thoroughly satisfactory system on the parallel-series plan were known. In that case high tension electricity might be used involving smaller conductors. Thus the central station might be at a distance, where land is cheap, and it might be of any size, so that all the works would be in the same place, as they are in gas distribution. Here the only departure from the ideal of economy lies in the length of the conductors to the district which has the supply. But these conductors are comparatively small, and no engineer would recommend the adoption of such a system unless he found that the economy of having the works out of the expensive district counterbalanced the extra expense in mains.

Now I regret to be compelled to say that, after discussing all the ingenious plans on the parallel-series-system proposed by Mr. Edison and others, I arrived at the conclusion that at this time there is no parallel-series system of distribution which is quite satisfactory. I do not say that such a system cannot be devised, but I do say that at this moment no such system is available to the electrical engineer, except in the case where the same quantity of electrical energy is consumed in any district at all hours during which the current is being used. There are some cases where it will pay to insert equivalent resistances when lamps are put out. These cases are rare, but they must not be lost sight of by the engineer.

Having in the Cantor Lectures discussed all the direct systems of distribution, I will complete my outline of this part of the engineer's profession by an examination of the two indirect methods which I formerly touched upon only lightly, viz., secondary batteries and secondary generators.

Secondary Batteries.

I have been given to test about a dozen different kinds of secondary batteries, of which I have found some four or five to be good, and the others mostly worthless. I can say this, that at the present moment secondary batteries can be supplied by certain makers which are to be relied on with careful usage, and which give us 70 to 80 per cent. return for the energy expended.

Now it might be asked what are the advantages of storing the energy if you lose 25 per cent. by doing so. The first advantage is that a breakdown in the machinery does not then interfere with the supply. The second advantage is that the steadiness of the supply does not depend upon the speed of moving machinery. The third and great economical advantage is that your expensive engines and dynamos are paying interest 24 hours of the day, instead of only a few hours, by doing their work; and a smaller supply of engines and dynamos suffices.

Now this is all very well, so far as having secondary batteries at the point of supply is concerned, but it does not help us much so far in the great problem which we have attacked, viz., that of electrical distribution. But the improvement of secondary batteries led to great hopes of a cheap system of distribution. It was said, "Put your generating station at a distance, on cheap ground, carry a current with high potential through light conductors to the district to be lighted. Pass the current through some thousand accumulators in series, placing these in batches of 50, say, each, in cellars, to light up a small district." The original idea was to keep the service wires permanently attached to the two ends of each set of 50 cells.

Now this plan is very beautiful if only it would work. But it will not work. The consumption being small from some of the cellars and large from others, and the same charging current going through all of them, the cells become overcharged in many cases, and this is injurious.

Another plan was proposed which I described in my Cantor Lectures. This was to introduce an arrangement to indicate when the cells were fully charged. By having two complete sets of batteries in each cellar, the indicator caused a rocking switch to act which switched the fully charged battery off from the charging mains on to the service mains, and at the same time switched the second set, which had, up to that time, been supplying the service mains, on to the charging mains. Here I would point out that, independently of the fact that we have no reliable indicator to show when the cells are fully charged, this only moves the difficulty back one step. For it will often happen that both sets are fully charged, and yet we are obliged to send current through one of them. This plan was tried at Colchester, but of course it had to be abandoned. If we had a true indicator to show when the cells are fully charged, the more sensible plan of using it seems to be to cause the indicator to disconnect the cells from the charging mains and connect the charging mains metallically. There would, of course, be a great fall of potential in lamps immediately after switching off the supply current, but the charging of the cells might be done by day or after midnight, during which time lamps are not very much used. I think that even this small difficulty might be got over by causing the indicator when it acts to increase the number of cells which lead to the lamps.

I suppose the most reliable indicators which could be used are those depending upon the specific gravity of the solution or the weight of the negative (oxydised) plate. Unfortunately, it is seldom found that a number of cells working in series become charged at the same time.

In fact, it is not very generally known that the most satisfactory plan for charging secondary batteries is to do so in quantity or parallel. When this is done, every cell is fully charged exactly at the same time, and all give off gas at the same moment. If there be any possibility of short circuiting, however, fusible plugs or other cut-outs must be inserted.*

To have a thoroughly satisfactory installation, it is necessary that the cells may be left in their secluded retreats without attention for long periods. I think I can safely say that cells can be so left if fairly treated. But the question is whether any scheme of distribution hitherto considered does give them fair treatment. If attendants have to be continually going round to inspect cells, this expense must be carefully calculated so far as is possible, and taken into account.

Now let me say a few words as to the improvements in secondary batteries. First, I may say that there is now no doubt that they can be made, and are made, by several makers of so good a construction that they can be used for years. I will not fix the number of years, because none of the most perfect ones have yet failed. Secondly, it seems to be conclusively proved that not only does no buckling take place, but there is no fluting or blistering if the plates are originally good, and if the air has not been allowed to reach them. Thirdly, we know that in overcharging them we do not injure them, but merely waste current. These are important facts, and are all we want for an installation where the state of the cells can be always under examination. For central station lighting we want something more. We want the cells to take current from the dynamos when they require it. For this we must have an indicator on the cells to work a switch, according to the state of charge of the current. Up to the present no satisfactory master cell has been devised. Those which depend on the gas given off do not act equally promptly with currents of different strength. The most promising system is one in which the state of the cell is shown by the specific gravity of the liquid. Very little ingenuity is required to develop this into a satisfactory system. But we cannot depend upon one master cell since it is only when charging in parallel that all cells act alike. If we have several master cells in each battery, all of which must act together to cut off the dynamo, I think we might depend upon their action. The function of the switch is—first, when the E.M.F. of the battery is too high, to cut out the dynamo circuit from the battery, to give a through connection to the dynamo current, and to switch in two additional cells to the lamp circuit; second, when the E.M.F. of the battery is too low, to break the charging current, to connect the battery to it, and to cut off two cells from the lamp circuit. These are all ordinary things which can easily be done.

But even without automatic action of this sort there are many large installations where it would be economical to use secondary batteries even if attendants had to be continually examining the state of the cells. The engineer who is designing an installation, if he does his duty, calculates the cost of every method of working which can be feasible.

The cost is of course an important item, and were it not that this system introduces a great saving in copper conductors and machinery, it would often be too expensive to work. We may take the cost of batteries at about £3 per lamp of 60 watts. The saving in copper conductors is proportional to the number of batteries put in series. There is also a saving in dynamos and engines. If we take four hours as the average time of using the lamps, we charge them, say, for six hours in the day time, and we use the dynamos as well as the batteries during the greater part of the night. Thus we require batteries and dynamos for only about one-half of the number of lamps generally in use. This brings the cost of batteries down to £1 10s. per lamp, and the cost of dynamos and engines from about £1 per lamp (the usual cost

* Even in this case we may have a partial short circuit, which will drain the current and yet will not cut out the cell.

for a direct service) to 10s. per lamp. This makes a total cost of £2 per lamp, as against £1 by a direct service. When we have made a further reduction for diminished size of conductors, and an increase for additional attendance, we are in a position to compare the two systems. But these figures vary so enormously that it is impossible to estimate them unless one has the details before him. We may say safely, however, that in large districts there is economy in secondary batteries, and in small districts in a direct service. But the advantage of not being dependent on the constant perfection of machinery is very great, and avoids the necessity for so complete a duplication of the parts. Of course the cost of working must also be made out, allowing for a loss of at least 20 per cent. in transforming through the secondary batteries.

The number of ways of using secondary batteries is great, but there are no engineering difficulties in the distribution, and I may, therefore, content myself with having drawn attention to the general advantages of using them.

Among the many special appliances used in this kind of work, I am glad to be able to show you some useful things supplied by the Electrical Power Storage Company.

Perhaps the most important of these is a switch for large currents, in which a number of concentric tubes have a longitudinal slot into which the arm of the switch is forced. The split tubes have a certain amount of spring, and literally cut into the arm of the switch, and so make good metallic contact. The one before you has been thoroughly tested with 1,500 ampères passing through it.

Another appliance is an automatic switch to reduce the number of cells in the lamp circuit when the dynamo is charging the cells and *vice versâ*.

A third is a cut-out to prevent damage to the charging dynamo by an accidental falling off of speed. It has this peculiarity, that it puts the battery in circuit again so soon as the dynamo resumes its functions.

In concluding this part of my subject, I would draw your attention to the scheme of lighting the Vienna opera house. The dynamos are by Messrs. Crompton, of 72,000 watts each, and are driven by direct acting Willans and Robinson engines. I am told that they give an electrical horse-power for 3·7 lbs. of coal. The secondary batteries are supplied by the Electrical Power Storage Company. The three-wire system is adopted, 110 cells are ordinarily in use with each circuit, and six additional ones are available to keep the electric pressure constant.

Secondary Generators.

I now come to speak of secondary generators, and since the principles which regulate their action are rather novel, it may be well if I spend a little more time in describing their action than I would otherwise do in a lecture treating chiefly of the manner of laying main conductors.

Everyone knows the principle of the induction coil. It consists of a core of iron surrounded by a coil of insulated wire called the primary coil, and by another one of insulated wire called the secondary coil. The secondary usually contains a larger number of turns and finer wire than the primary. The current in the primary is alternately made and broken by a simple automatic means. This magnetises and demagnetises the iron core. This is equivalent to introducing and withdrawing a magnet into and out of the secondary coil, and sets up currents in the secondary coil.

The electromotive force created in each turn of the secondary coil is measured by the number of magnetisations per second, and by the strength of the magnetisation. The latter is generally proportional to the number of turns in the primary, and to the current flowing through it. Thus the electromotive force in the secondary coil depends (1) on the number of turns in the primary; (2), on the number of turns in the secondary; (3), on the strength of current in the primary; and (4), on the number of makes and breaks in the primary current. Thus by having a large number of turns in the secondary coil, and a small number in the primary, a very high electromotive force can be obtained from a small battery connected with the primary.

If, on the other hand, a high tension interrupted current were sent through the fine wire coil we could get a large current from the thick wire coil.

Now, to feed a number of glow lamps in parallel, we require a large current, but this requires a large conductor. Here it was proposed to use a high tension alternate current (which acts just like an interrupted current) by a thin conductor from the works to the place of consumption, and there to transform it into a current of large quantity.

Then, again, another idea was thrown out. This was to carry the alternate current by a thin conductor round a large district, and at intervals to pass it through the first coil of induction coils, using the second coil to supply the lamps. Thus we should have a high tension current disconnected from the service conductors, and furnishing them all with a low tension current.

Induction coils used in this way have been called secondary generators or transformers. The perfection of manufacture of such apparatus consists in getting a maximum of induction and a minimum of heating. This has been admirably accomplished in the generators of Messrs. Gaulard and Gibbs. Instead of wire, the coils are made of copper discs, or flat rings split at one point, and with ears projecting outwards at the split. These discs alternately belong to the primary and secondary circuit, and successive discs of each circuit have the ears soldered together in such an order as to make up a spiral. The iron core is, of course, made of iron. [One could not reasonably expect it to be made of wood. —Eds. Elec. Rev.]

Although the even discs belong to the primary and the odd ones to the secondary, it does not follow that alternate discs should be coupled together. We may couple the 1st, 5th, 9th, &c., together, and also the 3rd, 7th, 11th, &c., so as to form two secondary circuits, which may be combined in parallel. The number of possible modifications of this sort is very great.

When the primary coil is magnetising and demagnetising the iron core, the latter sets up a counter electromotive force in the coil, and thus the current is largely diminished. But when there is no external resistance in the secondary coil, that coil being short circuited, then any magnetisation and demagnetisation of the core starts a current in the secondary coil, opposite in direction to that in the primary and almost equal to it. Thus the iron cannot get much magnetised, for it is surrounded by two opposing currents almost equal in amount. In this case, therefore, the primary has little or no counter electromotive force opposing it, and consequently it flows more freely. This explains a thing which often puzzles the beginner, viz., that with a constant electromotive force in the dynamo the current in the primary is stronger when the secondary circuit is closed than when it is open.

Very little energy is expended in magnetising and demagnetising iron wires. Thus there is really no loss of energy in the transformation, except that due to the heating of the conductors of which the coils are constructed, which is equal to the square of the current multiplied by the resistance. The loss of energy, which could not be accounted for, has been shown by Prof. Ferraris to be less than 1 per cent., and the practical efficiency of the generator amounts to as much as 95 per cent.

The theory of the secondary generators is very like that of the alternate current dynamo, if the reversals of magnetism of the armature were given by reversing the currents in the field magnets instead of by mechanical motion.

Coming now to distribution by secondary generators we find we must use the same principles as in direct distribution.

Parallel Distribution.—Let us take this case first. To do this economically we might lead two thin wires over the district and couple secondary generators to them. The condition of being able to have constant electric pressure in the lamps is that the electric pressure at the terminals of the primary should be constant. Here we meet the same difficulty as was experienced in direct supply. Consider three generators—1, 2, 3, fig. 1. If the lamps are all on in all three cases, then the pressure for No. 3 is

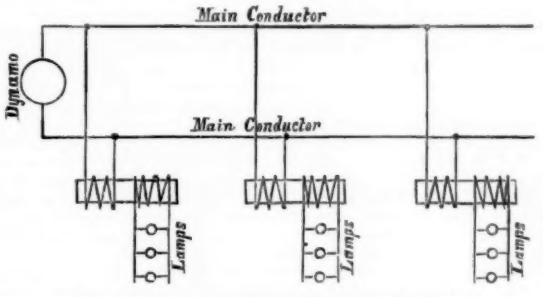


Fig. 1.—Secondary Generators in Parallel.

less than for No. 2, and that again is less than for No. 1. Suppose you try to rectify this by using lamps of lower pressure at the far station. In this case suppose the lamps in No. 2 are extinguished, then the pressure in No. 3 will go up and tend to injure the lamps. If you try to correct this at the central station you will lower the pressure of No. 1 till perhaps it only burns red. This difficulty is exactly the same as in the direct service. The remedy is of the

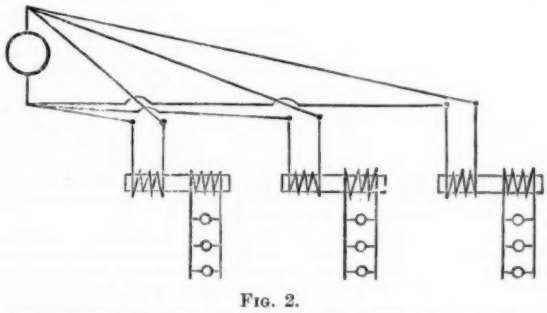


Fig. 2.

Distributing Boxes replaced by Secondary Generators.

same kind. You must use the generators as distributing boxes (see my Cantor Lectures, 1885), with separate wires from the engine to each generator, each one being fed with a different pressure from the engine house. Fig. 2 shows this arrangement. There is no objection to it except (1) that you must use a large

number of conductors, and (2) you introduce the full pressure of the high tension current into each house.

Finally, we come to distribution by generators in series. Here we have the best effect. A single wire (Fig. 3) goes round the circuit; if a double wire is used, to prevent affecting telephones,

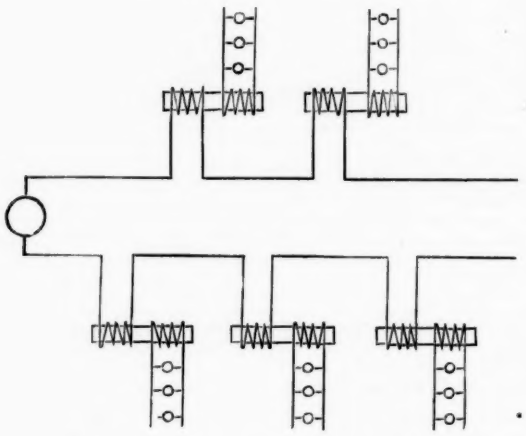


FIG. 3.—SECONDARY GENERATORS IN SERIES.

it is half the weight, and generators are alternately put on one wire and the other all round the district, and each pair of wires ends at a point far from the station. Suppose we use 10,000 volts, we may have 100 generators in series, each using 100 volts, or we may make any other arrangement. If it were done as I say, then following out the data of my Cantor Lectures, a wire of one square inch section will carry current enough for 100,000 lamps each consuming 60 watts.

In this arrangement we must send a constant current through the circuit. This is actually done by the introduction of resistances. It ought to be done either by an electric governor on the steam-engine, or by compound winding the alternate current machine, a matter about which there is no difficulty at all.

But how are we to attain to constant electric pressure in the lamps when we have got our constant current? This is a problem which has puzzled many people, and many have come to the conclusion that it is impossible to do it without mechanism. This used to be done by automatically introducing the iron core farther or less far into the coils. It is now done without any relative movement of the parts. This is the last triumph which has been added to a series of laborious experiments which year by year have brought us nearer to a solution of our difficulties. I am not at liberty to explain the *modus operandi*, but I have seen it at work, and it is very satisfactory.

The theory of secondary generators has been so little studied, except by specialists, that I have thought it might be advantageous to many if I added to this paper the formulæ which represent the electric current and pressure as depending upon the resistances and mutual induction of the various parts. These data will be found in an Appendix to the present paper.

I do not think it would be consistent with the objects of this paper to describe the specific differences between different kinds of secondary generators, or to attempt to give reasons for choosing one of these forms rather than another. I would merely draw attenton to the brilliant experiments on self induction by Professor Hughes, described in his introductory address as president to the Society of Telegraph Engineers and of Electricians. Professor Hughes has discovered a new and hitherto unnoticed source of waste of energy in self-induction, to remedy which it is essential to have the coils of the secondary generator made of discs.

I should also like, before leaving the subject, to dispel a growing error from the minds of some electricians. In speaking of different secondary generators, some persons are in the habit of speaking of one inventor's generator being used on a parallel system, another on a series system. This distinction is quite illusory. A generator made on any system is equally suitable for all kinds of distribution, and if an inventor states that his generator is only suited for one system of distribution he displays his ignorance, and shows that he has yet much to learn before he can say he understands the theory of secondary generators.

Last year, when speaking in my Cantor Lectures, I said that the Grosvenor Gallery installation would be followed with interest by engineers. I considered that it was a new test. Up to that time the method had been applied only to light districts where the number of lamps was constant. It was not proved that the method was suitable to the cases where lamps might at any moment be extinguished. Two things were necessary for this, (1) regulation of the current from the dynamo, and (2) automatic regulation of the electric pressure in the secondary circuit. Neither of these had then been accomplished in a manner which satisfied me, and I certainly considered it was a very bold step on the part of Sir Coutts Lindsay to adopt a system which was then so imperfect.

I am satisfied now that self-regulation of the secondary circuit is sufficiently perfect for practical purposes, even when the generators are in series; and I have pointed out to Messrs. Gaulard and Gibbs a further development which, in my opinion, will make their system even more perfect. The one weak point in the Grosvenor Gallery installation is the regulation of the current from the dynamo. Out of the four or five different methods by means of which this can be done, the worst has been applied up to this time, viz., hand regulation. The result is a frequent flicker in the lights. Still, when we consider that seven miles of route has been covered by the wires of this small association, and that on the whole great satisfaction is expressed by the users of the light, I must say that Sir Coutts Lindsay and his friends are to be congratulated on the great steps they have made towards success.

In conclusion, I wish briefly to allude to the present condition of electric lighting, and the prospects of economical distribution from central stations.

I have always maintained that there were three causes which retarded the progress of electric lighting.—(1), financial speculation; (2), the Electric Lighting Act of 1882; and (3), the unsuitability of the schemes of electrical distribution propounded by the contractors. I will say a few words on each in turn.

From the year 1881 to 1883 this country was the scene of a most senseless speculation, started by clever men of business, who took advantage of the interest in electric lighting caused by the Paris and Crystal Palace Exhibitions, and supported by dupes whose ignorance of electrical matters was only equalled by their want of common sense as business men. These men combined to purchase for large sums the right to use the apparatus of some particular manufacturing firm in a special locality. They never asked any competent person whether this firm's apparatus was better or worse than that upon which there were no royalties to pay. Those who were not clever enough to get out of the affair before the bubble burst were the sufferers, and the consequence was a panic in connection with electric lighting which has hardly yet subsided.

With matured knowledge confidence is again being restored, because the public learn from competent and disinterested persons that economical electric lighting can be accomplished without the necessity for paying the heavy royalties formerly demanded.

I trust that the warning of 1882-3 will not be lost on financiers, and that they will not be misled by untried but tempting schemes unsupported by capable men of science.

The next cause which has deterred electric lighting is the Act of 1882. This is an Act to give undertakers the right to break up streets in order to lay conductors, under certain conditions. It is these conditions which are so unjust. Some of our legislators, looking at the monopolies which exist in gas supply, are afraid that electric lighters will raise another monopoly. Consequently, they determined to hamper the electric lighting industry with conditions different to those imposed upon gas, and more stringent. They succeeded well, for they laid down such conditions that no sane man would invest in such a speculation. You would have thought it natural, I doubt not, that if the gas monopoly was truly so very irksome, the encouragement of a rival illuminant would have been the best cure for the evil, whereas our legislators acted as if they were parties interested in maintaining the gas monopoly, for they imposed such restrictions as rendered it impossible for electricity to be supplied to the public. Let me name one of their wise provisions. At the end of 21 years the local authorities can, if they please, buy from the company supplying electricity, the whole of their plant at the price of old material, without paying a farthing for goodwill or future profits, or past expenses in experimental and unprofitable work.

If, then, a company, after 21 years, were just making headway, and paying a dividend of 5 per cent. on their capital, the corporation would buy them up for perhaps a third of that capital, and get 15 per cent. But the case is even worse if the company is not yet earning a fair dividend, for then the corporation may hang over the company like a usurer over his victim, and each seven years it has the right to purchase the plant or not, and on the same terms as before.

Now, I agree with those who contend that electricity should be allowed to compete with gas under the same disabilities, and with the same advantages. This is not doubling a monopoly; it is splitting it into two, and destroying the monopoly, by allowing competition. If our legislators are not trying to uphold the gas monopoly, they must take this view. In any case, the public have shown that they will not submit to be deprived by legislation of this illuminant. The Board of Trade, I hear, have perceived their error, and are prepared to yield a little; but if they do not enable us to have electricity supplied to us, we, the public, must force their hand.

Still, electric lighting is not quite dependent on this Act. Local authorities have no penalties, and I would strongly urge them to take the matter up, for we have now arrived at a stage when it is safe and profitable to establish electric lighting on a large scale.

Again, you must remember that the disabilities of the Act apply only to those who lay their conductors underground and wish to break up the street. Sir Coutts Lindsay has taught us how to defy the Electric Lighting Act by passing the wires overhead. Those wires do not suffer like telegraph wires in snow storms, for the electric current melts the snow.

The third cause which deterred the progress of electric light-

ing, was the unsuitability of schemes of distribution which were proposed. I was impressed with this weak point at an early date. Sir William Thomson was the first to touch on the matter when he announced his law of the economical size of conductors. But the engineer had no tables to guide him as to the safety of these sizes of conductors in the matter of heating. I attacked this problem first in order to clear the way for scientific methods of dealing with distribution. In a paper read before the Society of Telegraph Engineers and Electricians, in 1883, I computed from the facts well known to physicists, the heating of different sized conductors with different currents, whether the conductors were bare, insulated, or buried. I had already, in a communication to the British Association in 1882, shown by experimental evidence, that the generally accepted laws required modification when we dealt with small wires.

The way being thus cleared, I attacked the problem of distribution generally, studying the various schemes which had been proposed or put in practice. My conclusions were published in the Cantor Lectures in 1885, and the most useful result was to announce a series of definite rules which must be attended to in order to provide an economical distribution. Since then some progress has been made, and the present paper will, I hope, bring the subject pretty well up to date.

The work which I undertook has been laborious, but it has been a very humble effort. I have brought forward hardly a single fact which could not have been foreseen by the competent engineer. But I think I have saved others from wasting their energy in repeating much of the work which is laborious; and I also trust that the outcome is a set of rules to guide those engineers whose purely scientific knowledge may be a little defective from falling into the gross errors which have been so apparent in nearly all attempts at lighting by electricity on a large scale which have been made in the past.

I now close the subject for a time, and if the labour I have bestowed upon it leads in any slight measure to establishing one department of electrical engineering on a sound scientific basis, I shall feel that in the work I have undertaken I have been of some little use to my generation.

APPENDIX.

The following formulæ give the currents and electromotive forces, on the assumption that the magnetism of the core varies as the sum of the currents in the two coils.

The E.M.F. of the dynamo is assumed as being—

$$\text{E sin. } mt$$

Then the primary current $= \text{I sin. } (mt + \gamma)$

secondary current $= \text{I}' \text{ sin. } (mt + \gamma')$

$$\text{I}^2 = \text{E}^2 \frac{\text{C}^2 + r'^2}{r^2 r'^2 + (r + r')^2 \text{C}}$$

$$\text{I}'^2 = \text{E}^2 \frac{\text{C}^2}{r^2 r'^2 + (r + r')^2 \text{C}^2}$$

Where C is a constant;

r = resistance of primary circuit;

r' = " secondary circuit.

Also the potentials at primary terminals $= v$;

and " " secondary terminals $= v'$;

where $v = \text{V sin. } (mt + \phi)$

$v' = \text{V sin. } (mt + \phi')$

$$\text{V}^2 = \text{E}^2 \frac{\rho^2 r'^2 + (\rho + r')^2 \text{C}^2}{r^2 r'^2 + (r + r')^2 \text{C}^2}$$

$$\text{V}'^2 = \text{E}^2 \frac{(r' + \rho')^2 \text{C}^2}{r^2 r'^2 + (r + r')^2 \text{C}^2}$$

ρ and ρ' being the resistances of the primary and secondary coils.

DISCUSSION.

Prof. HUGHES, F.R.S., said in his latest researches he had found that the maximum induction in iron took place when the iron was in the round form. If it was flattened, so that the contiguous portions of the current became separated from each other, the current was very weak; it had not one-tenth of its previous capacity. In the case of copper wire flattened, the reduction in the self-induction was about 50 per cent. Taking iron wire and passing a current through it, if you wished to have a secondary current parallel to it, the self-induction prevented the current acting on the secondary coil; in fact, the force of the electric current was used up in doing internal work. By flattening it, it re-acted on another wire to its full force, so that the energy which would have been used in self-induction, was transformed into the secondary current. He had not the slightest doubt that if this method were adopted, enormously more power could be obtained from the secondary coil. When two wires were flattened, the portions contiguous to each other did not re-act on each other with the same strength, but re-acted on any portion near; consequently, when there was another flattened sheet superposed, you had it in the nearest possible proximity. It was very remarkable that the same results at which he had arrived theoretically should have been worked out experimentally by Messrs. Gaulard and Gibbs, and they had arrived at the best possible conditions he could conceive for constructing a secondary coil. He had only one fault to find with it; the generator itself seemed perfect, but it required intermittent currents, and, therefore, it seemed to him there must be a loss in the line.

Mr. GAULARD (who spoke in French) thanked Prof. Forbes for his remarks upon the actual conditions and future prospects of the apparatus with which he was associated. He also thanked Prof. Hughes for his expressions respecting the mode of construction adopted, and in answer to the objection as to the great loss caused by the use of alternate currents for leads of great length, he said he could rely upon the experiments made with their apparatus, and reassure Prof. Hughes entirely on this subject. Their apparatus was constructed with two parallel circuits, forming spirals in the same direction. In order to obtain in the secondary circuit a variable electromotive force, they had contrived to unite in parallel and inverse directions the two circuits, and they had found that if in these conditions they sent through them an alternating current, the difference of potential at the ends of the spirals was directly proportioned to the resistance in the leads. If, on the other hand, they interposed in one of the connections a resistance, they found that the difference of potential at the two ends of the secondary circuit was, to a certain extent, directly proportioned to that resistance. From these observations it followed that if the leads consist of two parallel wires, and currents in opposite directions are sent through, not only no phenomenon of induction on the outer external circuit can appear, but no self-induction on these two leads can exist any more.

Mr. KAPP said he did not know much about the distribution of electricity, but he should like to add one more to the list of improvements which had been placed at the service of the electrical engineer, and that was the reduction which had been made in the speed of the dynamo. Machines were now running at half the speed of those constructed a few years ago, and in this way the chances of failure were enormously reduced.

Mr. B. DRAKE remarked that Prof. Forbes had drawn attention to the different ways in which electricity might be distributed for lighting purposes, but had not fully compared the relative advantages and disadvantages of the different systems. On behalf of secondary batteries, he would claim advantage in the practical impossibility of totally extinguishing a district through the failure of a single wire. No doubt there were many points which might be claimed on behalf of secondary generators, such as the first cost being less, and there being stronger metals in use which would be likely to last longer than lead plates, but at the same time the contingency of a station being extinguished all at once was an important consideration, and the fact of the engine having to be run to its full power whenever all the lights were required would more than balance the small extra cost of the accumulators in the first instance. The question had been raised as to the different details of apparatus necessary in connection with secondary batteries; they had been experimenting with every kind of apparatus for the last 18 months, with a view to ascertain how far it was really worth while to complicate the system by putting in automatic contrivances, and after designing all sorts of apparatus, they had come to the conclusion that the whole thing ought to be kept as simple as possible. When a cell was practically empty, you required only 2·2 volts to charge it with a certain current, whereas to get the same current through it when the cell was full required over 2·5; the cutting off of a definite number of cells was therefore practically not worth the cost of the apparatus. It was, however, found advisable to introduce some kind of automatic switch in any installation where the attendant ever had to leave the engine. There was again the question of the regularity of the light. If the engine power varied at all where secondary generators were used, that variation was transmitted throughout the whole district; if a bearing ran hot, all the lights felt it; and in addition to that, there was the variation which Prof. Forbes now said had been nearly overcome, which was due to varied consumption at different points of the circuit. With secondary batteries none of these evils occurred, and if some apparatus could be made reliable for cutting them in and out when fully charged, it seemed to him the solution of the problem would be complete. He agreed with Prof. Forbes that the specific gravity was the right principle to adopt in cutting out the accumulators, and that the master-cell system would be much improved by having two master cells which would have to be completed before the automatic cut-out would work. The difficulty with the specific gravity apparatus was this. The carrier which carried the whole apparatus had to float as well as the hydrometer, and in order to do that, the cell containing it had to be enlarged. In that way the bulk of the acid was enlarged, and consequently, the range in specific gravity became so extremely small, that you could practically do nothing with the small variation of the hydrometer. On the other hand, with the extremely small space which was necessary to get any appreciable variation, you had to employ such a small apparatus, that you could hardly rely on its working properly. The only way to get any results was by a system of relays, and that was difficult near accumulators, because the contacts got corroded by the acid. No doubt the advocates of the other system would be able to point out objections to secondary batteries, and he should be much interested in hearing them.

Mr. MORDEY thought the carbon resistance gauge shown was very similar to that which had been made for years by the Brush Corporation, consisting of a series of small carbon plates in a case, with a screw or lever arrangement to enable the resistance to be varied by alteration in the pressure. The principle had been used by Mr. Brush in his automatic regulator. The original principle he believed was due to M. Clerac, who communicated it to Prof. Hughes in 1867. With regard to lamps of low resistance,

he might say that on some circuits at Eastbourne and also at Brighton, the plan had been in operation, not with so low a resistance as Mr. Bernstein used, but so low as to allow of three lamps in a group being used, instead of eight or nine; each lamp taking a current of 3·3 ampères, the normal working current being 10 ampères. The manipulation of a group of lamps was very much simplified when the number was reduced; and if it could be reduced to one, and a constant current could be maintained through the circuit, the perfection of simplification would be attained; but even where three had been used in a group, with about 15 volts at the terminals, the manipulation of each group was not a serious matter. Where people employed a large number of lights, they might object to turn out eight or ten, but the same objection did not apply to a group of three. He should like to ask if there was any advantage in using secondary generators in the manner shown in the diagram in parallel; it seemed to him that all the effect thus obtained could be obtained much better by the ordinary direct supply. The cost of leads and the whole of the problems connected with the question would be much the same in each case. Another point in connection with secondary generators was of great scientific interest, and that was as to the actual loss of energy in the iron of the core due to the rapid magnetisation and demagnetisation. There had been a great deal of discussion of late years as to whether any energy was really lost in this way, and it was a very difficult subject to work at, because it was almost impossible to eliminate the effect due to eddy currents, and that due to the turning over of the molecules, as Prof. Hughes would call it. In an ordinary dynamo machine, where the reversal of polarity was not so rapid, only 400 or 500 revolutions a minute, and the molecules only required to be turned over 800 or 1,000 times a minute, the difficulty was not felt, but in secondary generator coils, where the reversal of magnetism took place thousands of times in a minute, it would be very different, and he should like to know if the actual loss had been ascertained.

Mr. GAULARD, in answer to the observations respecting the great loss which might result from the retardation in the molecular vibrations, produced by a very great number of alternations—an opinion based upon certain facts observed in the use of a current having 1,000 alternations per minute—he would point out again that, in the experiments made by the International Jury of Turin upon the secondary generators by the most exact method, the calorimetric method, the current used had 16,000 alternations per minute; the yield had been proved to be 95 per cent. This is the greatest number of alternations obtained till now, by an alternate current machine of the largest type known, and perfectly sufficient, he thought, for producing the highest electromotive force which may be wanted from a practical point of view.

The Chairman, Prof. W. G. ADAMS, F.R.S., drew attention to the several points which had been raised by Prof. Forbes, and which had been brought out in the discussion, such as the relation of the size of conductor to the mode of distribution, and especially the part played by secondary batteries, and, again, the important applications of secondary generators so ably explained by M. Gaulard. Now that electric lighting was not going forward with such hot haste as it was two or three years ago, those who were connected with it had more time to think about the best and most efficient methods of doing the work, and the lull would be found to be a time of great profit to electric lighting. We may be thankful to Prof. Forbes for making the question of the size and arrangement of conductors so much his own, and for giving us the benefit of his researches in this direction. We must also thank him for so ably bringing before us in the Cantor Lectures, and in his paper this evening, the results of a great deal of thought and experiment on the different systems of lighting. Thanks to his and other researches, we may say that electric lighting is on a much more stable basis than it was three years ago. When it was stated that you could depend on getting out of storage batteries 70 or 80 per cent. of the energy employed, it was evident that a great step had been made during the last three years. Coming to the question of secondary generators, a very successful experiment had been made—indeed, it was almost more than an experiment—by Sir Coutts Lindsay. He might also refer to the experiment made some time ago by Messrs. Gaulard and Gibbs, in which they lighted up part of the Metropolitan Railway—from the Edgware Road Station to Aldgate in one direction, and Notting Hill Gate in the other—from one central station. The apparatus exhibited this evening showed that even then they had made very great progress, and that they had gone far ahead of the position to which they had then attained.

Prof. FORBES, in reply, said some of the points raised had been already answered. M. Gaulard had replied to Prof. Hughes by telling him of the effect of the double line; and he would observe that in doubling the line it was not necessary to double the quantity of metal, because, as shown in the sketch of the series arrangement, when you doubled the line, you tapped both wires, and therefore made the wires half the section they would otherwise have been. He ought to have congratulated Mr. Kapp on the improvements he had effected, but he should congratulate him on increasing his magnetic induction and the capacity of his machine, more than on diminishing its speed. It was perfectly true there might be less chance of failure in a machine when running at half speed than at the speed it used to run, but at what a tremendous cost that safety was obtained. The machine ought to do double the amount of work it did at that reduced speed. When there was a central station to light, the dynamo must be run at a reduced speed, but it must be made up for in another way by increasing the size. When there were large districts to light, it would be economical to have large machines going at comparatively slow speeds. When Mr. Drake came to look at the paper, he thought he would find that he had given full credit to the advantage he had mentioned of a district never being put in darkness through one wire breaking. He was sorry to hear that the sum total of 18 months work was, that they could not leave the batteries alone to automatic appliances to work themselves, and he trusted that Mr. Drake would reconsider that question. He hoped to see secondary batteries largely used in central station lighting, but if it involved the necessity of attendants going round to look after them and switch them in and out, it would be a serious drawback to their introduction. He ought to have mentioned that it was Mr. Drake who originally suggested to him the use of two master cells. In reply to Mr. Mordey, of course he did not mean to say that the use of carbon plates as an adjustable resistance was new, but he drew attention to this instrument of Mr. Varley's because he believed it was new, and it possessed advantages he had not seen in any previous arrangement. It was perfectly adjustable by the screw, and did not require knocking on the table to shake the pieces apart, as he had found with Mr. Brush's apparatus. With regard to the advantage of using secondary generators in parallel, he would point out that if the station were at a great distance, very thin conductors might be used to the generators. You might use a primary circuit of any series, and take as the secondary coil a number of discs in parallel, and so use a high tension current, thousands of volts in the primary, and yet have only 100, or whatever was required, in the house, and have all the economy of thin conductors. With regard to the loss of energy in magnetising and demagnetising, he agreed with M. Gaulard that it was an extremely minute quantity which could not be detected; the loss when a core of iron wire was used was very small indeed.

The CHAIRMAN then proposed a vote of thanks to Prof. Forbes, which was carried unanimously.

REVIEW.

School Electricity. By J. E. H. GORDON, B.A. London: Sampson Low, Marston, Searle and Rivington, Crown Buildings, 188, Fleet Street.

The object of this work is to give schoolboys a knowledge of electricity which, however incomplete, shall be of a useful kind. The work commences with the study of electric currents, showing what their principal effects are. At the end of the chapter (and, indeed, at the end of all the chapters) we have a series of questions given dealing with the subject matter which precedes them. In Chapter V., where the "Electrical Units and their Relation to each other, and to the heat and work units" are dealt with, we have a number of numerical examples given which must be of very great assistance to the scholar studying the subject. In the questions at the end of this chapter several are of a numerical nature, and it is much to be regretted that the answers to the same are not indicated. In many cases physical examples from other branches of science are given in explanation of particular phenomena; this is a great help, and is a point worthy of commendation. Taking the book altogether it is likely to prove very useful for the intended purpose, though a certain amount of the matter is, we think, rather beyond the range of boys of even high mental capacities. The book terminates with a series of examination papers, and here, again, we must express regret that no answers, to the numerical questions especially, are given.

Is it the Effect of Government Control?—In the course of some retrospective remarks, and speaking of the advances made since the death of Galvani on February 5th, 1799, the *Electrical World*, contrasting what has been done respectively in America and in England, says:—"The English Government last Thursday completed their sixteenth year of monopoly of the telegraph lines (February 4th, 1870). They have little improvement to show for their sixteen years of exclusiveness, except their record of a determined effort to crush out the telephone. On the other hand, during that period of only sixteen years we have tossed off the duplex, the quad., the telephone, and a few other trifles that are only born of or nurtured by a spirit of keen competition."

NOTES.

Electric Lighting at the Edinburgh International Exhibition.—The members of the Executive Council and Committee of the Edinburgh International Exhibition dined together last week, Lord Provost Clark presiding. Among the speakers on the occasion was the Lord Dean of Guild, who said that they were blamed at first for aspiring to a guarantee fund of £25,000, which they put forward with some timidity, but it had now reached £36,701. They expected at the beginning to let 80,000 feet of space, but they had now allotted 109,685 square feet. They had also had the good fortune to have two excellent architects, and it had been said that the Exhibition was the best that was ever planned. The electric light would cost about £5,000, and their display of machinery would be greater than anything that had been in London.

Electric Lighting of the Post Office Savings Bank.—The trial test of the large installation, which has just been completed by the Maxim-Weston Electric Company, at the Post Office Savings Bank, was made last week in the presence of Mr. Blackwood (chief secretary, General Post Office), Mr. E. Graves (chief engineer), Mr. W. H. Preece (Government electrician), and other officials of the Post Office, and Mr. Hugh Watt, M.P., chairman of the Maxim-Weston Company, with other gentlemen. The installation has been divided into 36 circuits, and by means of a switch-board, weighing about 3 cwt., has been so arranged that any section of the installation can be switched on to any of the dynamos. This was done successfully in the case of 12 of the different sections, and run in all for about two hours. The Post Office officials expressed themselves well satisfied with the test made, and the installation was duly passed by them on behalf of the Post Office authorities; Mr. Preece further intimated his entire satisfaction with the steadiness of the light.

Electric Lighting in the City.—Colonel Haywood, the City Engineer, in his report of the year's work to the Commissioners of Sewers, says with regard to electric lighting:—"Upon the whole it appears desirable for the Commission to offer very liberal terms indeed to those willing to embark in the enterprise of supplying a fairly-sized district in the City with electricity rather than to undertake the work themselves. The risk of profit to the enterprise would be considerable, even if the promoters be paid most liberally for the supply they give; but whatever the cost may be, it would be a cheaper and a better way of obtaining a supply of electricity, either for the City of London or any part of the metropolis, rather than for local authorities to undertake it in the present condition of electrical science. Unfortunately, at the present time there is a complete stagnation in electrical enterprise upon a sufficiently large scale for the supply to a town or large district. This I believe to be solely attributable to the operation of the Electric Lighting Act, under which those embarking in such undertakings are fettered in many ways, and may, after a large expenditure and years of trouble, be deprived of the fruits of their labour with most inadequate compensation, just when success might begin to reward them. Nothing short of the repeal of that Act, or a fundamental alteration in most of its provisions, will bring capital into electrical undertakings again; and the Commission would, I believe, most usefully use its power and position in obtaining an alteration or repeal of the Act."

The Ball Electric Lighting System.—This system seems to be finding favour in the States, for we hear that the Ball Company is crowded with business, and is arranging an enlargement of its facilities of manufacture. Mr. H. W. Spang, a well known citizen of Reading, Penn., is president of the company, and under his direction the business is rapidly extending.

Electric Lighting of the Indian and Colonial Exhibition.—According to the *Society of Arts Journal*, the supply of motive power for the internal lighting of the forthcoming exhibition has been, as at the three former exhibitions, entrusted to Messrs. Davey, Paxman & Co., of Colchester, while the actual lighting of the buildings has been placed in the hands of five well-known firms. Messrs. Galloway and Sons, of Manchester, take the place of Messrs. Siemens Brothers as contractors for the garden lighting. Sir Francis Bolton will again preside, from the clock tower, over the fountains, from which novel features may be expected. On entering the buildings in the evening, one will miss the myriads of little star-like lamps which formerly met the gaze in the southern galleries, and will find in their place fewer but more powerful arc lamps. The whole of the electric lighting is under the superintendence of a committee, appointed by the Executive President, of which Sir Frederick Abel is chairman.

American National Electric Light Association.—This association, which was formed last year, commenced this year's convention at Baltimore, on the 10th inst., when the following programme of the work of the convention was promulgated:—Report of the Executive Committee on Credentials; naming of those who are entitled to seats in the convention, giving separate lists of the active and associate members. Papers: "History and progress of Electric Lighting," by Geo. Worthington, of New York; "Electricity as an Illuminant," Geo. S. Bowen, of Elgin, Ill.; "Arc Lighting," by Wm. Hochhausen, of New York; "Incandescent Lighting," by Dr. O. Moses, of New York; "Storage Batteries," by Prof. George Benjamin, of New York; "Use of Electricity in Lighthouses," Major Heap, Washington, D.C.; "Best Equipment for Arc Lighting Stations," D. E. Evans, Baltimore; "Underground Wires," by Ralph W. Pope, of New York; "Steam Power," by F. Fosdick, of Fitchburg, Mass.; "Operating Expenses," by E. R. Weeks, of Kansas City; "Relation of Electric Lighting to Insurance," by C. J. H. Woodbury, of Boston, Mass.; "Proper Construction and Maintenance of Circuits," by E. R. Weeks, of Kansas City; "Carbons and Globes," by Frank Ridlon, of Boston, Mass.; "History and Progress of Electricity, as applied to Motors," by W. J. Johnson, of New York; Report of Conference Committee on Uniformity of Prices for Apparatus in Service, by Frank Ridlon, of Boston, Mass.; Annual Election of Officers; Resolution fixing the place of the semi-annual meeting.

The Thomson-Houston Electric Lighting System.—The Thomson-Houston Company has orders for the following plants:—Worcester, Ohio, 30 lights; Waterbury, Conn., 30 lights (increase) for the Connecticut District Telegraph and Electric Company; La Fayette, Ind., Gas Light Company, 30 lights; Sheldons and Sons, Marble Workers, Rutland, Vt., 45 lights; Northampton, Mass., 30 lights; Aqueduct, New York, 30 lights, increase, making the eleventh machine installed there; Wilmington, N.C., 25 lights; Durham, N.C., 50 lights; Woonsocket, R.I., 38 lights increase.

Electric Lighting at Kimberley.—The Mayor of Kimberley prepared a lengthy minute of the proceedings of the past year, and recently presented it to the Town Council, Respecting the electric light department, he said: "A sum of £2,000 has been expended in this department on additional plant and improvement of old plant, enabling the service to be extended by another 14 lamps and at very little extra cost for maintenance. Proposals have been made to light up the railway station by this department, but as yet no satisfactory reply has been received from Government on this subject. The system of private lighting on the incandescent principle has already been discussed by the Council, the adoption of which would, no doubt, prove a source of revenue. I think I am safe in saying that this is the only town in South Africa the streets of which are lit by electricity."

Economy of Electric Lighting.—The Boston, U.S., Post Office, it is stated, saved $10,000 last year by the use of the incandescent light instead of gas.

The Telephone on a Steamboat.—A telephone has been placed on board the steamer *Monohansett*. The wire is along the wharf at New Bedford, Mass., and connected with an instrument in the office. As the steamer leaves the wharf the wire is automatically detatched. This is said to be the first telephone ever put into a steamboat.

American Telephone Patent Litigation.—A dispatch from Washington, dated February 4th, states that the House Committee on Expenditures in the Department of Justice, agreed upon a resolution calling upon the Secretaries of the Treasury and the Interior and the Attorney General for information as to the amount of money, if any, which had been expended by the Government in the telephone cases recently before the Interior Department. Solicitor-General Goode is now engaged in the preparation of a bill to be filed against the American Bell Telephone Company, to vacate and annul its patent. He says that the suit will be instituted as soon as the papers can be prepared, and that no decision will be reached in regard to the place of bringing it until all the papers are ready.

Recent revelations in the *New York World* respecting the Pan-Electric Telephone Company, with which Attorney-General Garland is officially connected, show that the official influence of its leading members was mainly relied upon to make its stock valuable. It is said that the Government cannot conduct the litigation for less than $200,000.

Limitation of Telephone Dividends.—The Edinburgh Chamber of Commerce met last week and adopted a motion by Mr. R. A. Macfie, of Dreghorn—"That the directors take measures, in concert with other chambers of commerce, to see that the interests of the public were safe-guarded in any arrangements that might be made throughout the country with the National Telephone Company." Mr. Macfie thought it was reasonable that the dividends of the company should be limited, say, to 10 per cent.

The Plymouth Telephone Exchange.—Some interesting statistics have been published with reference to the progress of the "Three Towns Telephone Exchange," which has its headquarters at Plymouth. During the twelve months ending December 31st last, it is computed that no less than 18,860 calls were received, each conversation lasting on an average about two or three minutes. Thus, 56,580 minutes, or 40 actual days were occupied in these conversations. It being a well known fact that 100 words a minute can be safely spoken through the telephone, the estimated number of words spoken through the telephone, during the period referred to was, on this calculation, 5,658,000; and this not taking into account conversations between subscribers and operators, estimated at 653,280 words. Of course, every additional subscriber makes a difference to the number of calls. There is an increase of 90 subscribers on the previous year. During the last month, there have been 4,380 calls, but notwithstanding the severity of the weather of late, complaints have only been received in eight cases. There is still great scope for the development of the telephone in the Three Towns, and during the present year, the roll of subscribers may be expected to receive considerable augmentation from those tradesmen who as have yet ignored the great assistance to commerce which the telephone undoubtedly is. The fact is, people have scarcely yet got used to the telephone, with its innumerable advantages, being within their reach, but its merits are being so well advanced and advertised in the West, that a change must soon come o'er "the spirit of the dream."

Overhead Telephone Wires.—A correspondent writes to the *Times*:—"A circular of the United Telephone Company is going the round urging London solicitors to become subscribers to a telephone system proposed to be established in the new Law Courts, and offering to run wires thereto from each subscriber's office; 260 solicitors already use the telephone, and if the number increases it may be that in self-defence the whole legal community of 4,000 will feel compelled to substitute air messages for postal ones. In this state of things it is to be hoped that Parliament will at last step in. The report of the Select Committee of last year on telephone wires, as drafted by the Chairman, Mr. George Russell, specified, as he lately informed you, certain precautions as necessary in order to render safe the continuance of overhead wires. His draft report, which was not accepted, differed mainly from that of the majority of his committee in distinguishing between the rights to be accorded to the Postmaster-General and to private companies and others; the accepted report made no such distinction, but recommended that both should alike have power to pass wires over private property without consent of owner or occupier. The difference, as will readily be seen, is a vital one. The present growth of overhead wires is due not to the postal authorities, but to the telephone and other private companies, who, although paying a large royalty to the Postmaster-General, are not in any way subject to his control. It has been stated that the Postmaster-General has of late reduced his overhead wires by one-third, proving that he, at all events, does not favour the overhead plan. The fact of the crowded condition of subterranean London, especially in the City, not to speak of the expenses involved in interfering with asphalte and wood roads, or of consents required from road authorities, is sufficient doubtless to deter private companies from spontaneously following the lead of the Post Office. Pressure should, however, be brought to bear upon them, and the course which such pressure should take is, it is suggested, for Parliament at once to stop all further overhead wire-works by any person or company not specially authorised. The effect of this would be to drive the telephone companies into seeking Parliamentary powers, when Parliament would doubtless take care to impose conditions protective both of private rights and of the public safety."

Telephone Extension in Fifeshire.—The National Telephone Company is taking active steps towards establishing telephone exchanges in the various towns throughout the Kirkcaldy district. Already sufficient support has been obtained in Stirling and Alloa to enable them to make a start, and a connection will be made also with Glasgow. The company is at present soliciting support in Dunfermline, and should it be successful, connection will be made from there to Stirling on the one hand, and to Burntisland and Kirkcaldy on the other. Kirkcaldy will then be in direct communication with Glasgow, which will be of immense utility. An extension of the system to Cupar-Fife, St. Andrews, and Dundee, is also proposed, and efforts will shortly be made to obtain the necessary support.

Lecture on the Telephone.—Mr. Townsend, district manager of the National Telephone Company for Fifeshire, last week delivered a lecture on "The telephone in its history and applications" before the members of the Kirkcaldy Naturalists' Society, and was listened to with great interest.

Delivery of Telegrams.—In answer to Mr. Forwood, in the House of Commons on Monday, Mr. H. Fowler said it had been discovered at the Post Office that an address which might be sufficient for a letter might be insufficient for a telegram. Insufficiently addressed letters were intrusted to postmen familiar with the names of residents in their district, whereas the same

information was not possessed by telegraph messengers. What was required was an address which should enable the messenger to deliver the telegram even without the name of the person to whom it was sent. If the hon. member would furnish him with the particulars of grievance he would see that the matter should be investigated.

Telegraphic Revenue.—The receipts on the telegraph service from April 1st, 1885, to February 20th, 1886, amounted to £1,535,000, against £1,550,000 received from April 1st, 1884, to February 21st, 1885.

Girls in the Telegraph Service.—"Dogberry," who writes in the *City Press*, makes the following statement:—The question is often asked, What shall we do with our girls? It may be interesting to parents to know that at a recent preliminary examination of telegraph girls—60 being wanted—1,200 presented themselves. I understand these telegraphists get 12s. a-week to commence, and an increase of a shilling a-year.

Military Telegraphists' Dinner.—The non-commissioned officers of the 2nd division, telegraph battalion, Royal Engineers, met at dinner on February 5th, the 16th anniversary of the transfer of the telegraphs to the State, and subsequently passed a pleasant evening in song and speech. Major-General Webber, Mr. C. H. B. Patey, Mr. W. H. Preece, Mr. E. Graves, Lieut.-Colonel du Plat Taylor, and other gentlemen were amongst the visitors.

Proposed New Postal Telegraph Offices at Southampton.—At the last meeting of the Southampton Town Council, Mr. Lankester gave notice that at the next meeting he should move a resolution to the effect that the council should memorialise H.M. Board of Works that in connection with the new buildings now being erected at the back of the Post Office in the High Street, they should cause to be erected a building of such architectural character as would make the post office one of the most important buildings in the town, and be suitable to the importance of the borough.

A New System of Telegraphing To and From Moving Trains.—For several months past Mr. Edison, in connection with Mr. E. T. Gilliland, has been engaged in improving and elaborating the original idea of Mr. W. Wiley Smith, who proposed to communicate with moving trains by means of static induction between the metal roof of the cars and a telegraph wire, running parallel with the road. A section of the Staten Island Railroad, 13 miles in length, has recently been equipped on this system, and a first public test, a week or so ago, is said to have been in every way successful. Many messages were sent to and from the train while in motion, and with an ease and speed which left nothing to be desired. The representative of the *Electrical World* sent to his office from the moving train a message, which was received without any delay. The apparatus, both on the train and at the station, consists of the ordinary Morse key, a telephone as a receiver, and an induction coil for charging the wire and roofs of the cars respectively. A vibrating reed, or buzzer, in the circuit, gives a continuous musical note in the telephone, which is broken into dots and dashes by the closing of the Morse key. In this system the metal roofs of the cars are used without any alteration, and the ordinary telegraph wire upon the poles is employed. The Railway Telegraph and Telephone Company is operating the system, with which it intends shortly to equip several railway lines.

The Patent Laws.—The Committee appointed by the President of the Board of Trade to enquire into the duties of the Patent Office under the Patents, Designs, and Trade Marks Act, 1883, will consist of the Earl of Crawford and Balcarres, Baron Henry de Worms, M.P., Sir Bernhard Samuelson, M.P., Sir Richard Webster, Q.C., M.P., and Mr. Acland, M.P.

"Dynamo Electric Machinery."—In our article on this subject in last week's issue, by some unaccountable means an error crept into a sentence relating to the temperature of the dynamo which was not present when the last proofs were read. The sentence in question, which is on the lower part of the first column on page 157, should read: "There is no reason why the large dynamo should be worked at a higher temperature than the smaller one, and instead of the current being n^3 it ought to be less than n^2, really $n^{\frac{1}{2}}$," &c., the index of n in the last instance having disappeared in our last week's issue. In another part of the article we speak of the "horizontal component of the earth's magnetic intensity," whereas it should be the "vertical component," Thompson placing the armature horizontally with the axis in the magnetic meridian, the E.M.F. produced, therefore being due to the *vertical* component only.

Addresses of Patentees.—The correspondent who desires to learn the addresses of the applicants for the New Patents announced by us each week, will find what he wants in the *Official Journal of the Patent Office*, which is published twice weekly at the Patent Office publishing department in Cursitor Street.

The Science of Electricity.—At the last meeting of the Portsmouth and Gosport Natural Science Society, the president (General Drayson) in the chair, Mr. Sandy, the local manager of the Western Counties and South Wales Telephone Company, read an interesting paper on the history and progress of the science of electricity. Mr. Stelling, in moving a vote of thanks to the essayist, gave some interesting details of the experiments of Sir Charles Wheatstone, a relative of his, which led to the development of the telephone.

Volk's Electric Railway at Brighton.—The report of the Watch Committee on a letter received by them from Councillor Challis, asking why Volk's electric railway car was not rendered amenable to the bye-laws in the same way as any other public conveyance, was submitted to the last meeting of the Brighton Town Council, when the reply of the Town Clerk that the car in question did not require a license was endorsed.

Multum in Parvo!—In our last issue we notified the registration of Hirsh, Greystock & Co., Limited, with a capital of £50,000, for the purpose of purchasing the business of Walter Moser, portable electric light manufacturer, trading under the above appellation. The following advertisement, ruthlessly torn from a daily paper, contains some startling, yet discreet, announcements:—

"Electric Light Simply Marvellous. One Farthing per Hour.

"The Portable Electric Light gives a White Incandescent Light of many Candles, and Burns for about Three Hours without re-charging, which a child can do.

"The Portable Electric Light. No Danger, No Heat, nor anything unpleasant.

"The Portable Electric Light. Size 5 inches square. The price complete is only 30s. Order early.

"P.O. or cheque to be sent to Hirsh, Greystock & Co., Limited, Electric Lighting Contractors by Primary Batteries for Domestic Lighting, &c., 11, Queen Victoria Street, London, E.C."

It will be noticed that the candle-power per farthing hour is left to the reader's own estimation—a wise proceeding. The child which is father to the man is generally looked upon as being somewhat precocious, but what shall be said of the child which can burn for about three hours without re-charging? It is to be feared that Messrs. Hirsh, Greystock & Co., have not selected a very opportune moment for the disposal of their wares, for in these days of trade depression we imagine that but few will be found who will not consider twice before investing their 30s., be the bait never so temptingly prepared.

Primary Battery Rights.—Mr. Charles S. Stewart asks us to contradict the report that he has sold his primary battery rights to Messrs. Grant Bros., of High Holborn.

The Glasgow Philosophical Society.—At a meeting of the Glasgow Philosophical Society last week, Mr. Joseph W. Swan, inventor of the Swan electric light, read a paper on "An Electric Safety Lamp for the Use of Miners, &c." Mr. Swan directed attention to the great simplicity and power of the combination of zinc and peroxide of lead, which he had made use of in the primary battery. It was a combination proposed by De la Rive nearly forty years ago, and had been entirely neglected. The electromotive force was 2½ volts, only one liquid was used, and that not a primary one (dilute sulphuric acid), and the exhausted peroxide poles could be re-oxydised by means of the dynamo at a very small cost. In reply to a question at the close, Mr. Swan said he was not yet able to state what would be the cost of such lamps, but the cost of maintaining them would not be greater than the cost of the lamps at present in use—viz., about 4d. a week.

A paper on "Direct-reading Galvanometer for Strong Currents" was read to the meeting by Prof. Blyth. He described a modification of the current weigher, by means of which the strength of an electric current could be determined by calculation alone. It consisted of two circles of wire placed, with their planes horizontal and parallel, at a known distance apart, and so attached to an ordinary chemical balance that the repulsion between the wires, when each carried the same current, could be accurately determined in grammes. From this weight, and the diameter and distance apart of the coils, it was shown how the current strength could be accurately ascertained. It was stated that this method of measuring a current was free from the errors incident to the various forms of tangent and sine galvanometers, which equations involved as a factor the horizontal intensity of the earth's magnetism, which was a very variable quantity, and difficult to measure exactly. The Professor then described a new form of galvanometer for the measurement of strong currents. The peculiarity of this instrument was that its indications are directly proportional to the current strength through all ranges. By adjusting the length and thickness of a torsion wire it was shown that the instrument could be made to read either ampères per degree or per two degrees, as might be desired. A modification of the instrument was also explained, in which the deflections were proportional to the square of the current strength.

Discovered at Last.—First Kentucky Colonel: "I see that a man in Pennsylvania has made a great discovery."—Second Kentucky Colonel: "Ah, what is it?" "He thinks he can decompose water and produce an excellent illuminant." "Is that so? Well, do you know I always expected that some use would finally be found for water."

Charging Secondary Batteries.—Is Professor George Forbes correct in his assertion that secondary batteries are best charged in parallel? If he could ensure the resistance of all the cells to be perfectly alike, the method might be feasible; but, if we are not mistaken, the manufacturers of these batteries do not adopt the course advised by Mr. Forbes.

The Cowles Electric Furnace.—We bring before our readers this week the very interesting subject of the Cowles electric furnace, employed in the United States for the production of aluminum and its alloys. Hitherto, we believe, this apparatus has been but briefly touched upon by the technical journals in this country.

Removal.—Messrs. G. Binswanger & Co., manufacturers and patentees of electrical apparatus and insulating material, have removed from 29, Aldermanbury to 5, Great St. Thomas Apostle, Queen Street.

Secondary Batteries.—In an article upon secondary batteries, the *Electrical Engineer* says: "According to the patents of FitzGerald and his colleagues, no grid or supporting frame is required, the electrode being made of finely-divided lead pressed into flat thin cakes, a system developed in the various patents of Mr. Desmond FitzGerald, who has, if reports be true, made the greatest step of all, namely, the production of a conducting peroxide plate or electrode, not supported by a grid, and the efficiency of which is said to leave all others far behind in every respect. We are told that a battery made under Mr. FitzGerald's recent patents has been tested in Paris, and a report written thereon by M. Hospitallier. This is said to be highly favourable in every way, but it seems curious that the proprietors should prefer to show the battery first in France, and have it first reported upon by a French *savant*, instead of showing it first in England. Mr. FitzGerald is known to have done some of the most important work in the invention and development of secondary batteries, but by some unfortunate combination of circumstances the results of his work seem to be locked up by him or by those to whom the patents belong, and this is the case with other important inventions by the same electrician. The patents of Mr. FitzGerald and his colleagues are those which originated the employment of finely divided lead or oxides, moulded or pressed into flat cakes, and it seems strange that batteries constructed on their system should not yet, as far as we are aware, be in the market."

Electrical Fire Alarms.—On the evening of the 23rd inst. Mr. W. L. Carpenter, manager of the School of Electrical Engineering, Princes Street, Hanover Square, made an interesting contribution to the weekly series of Penny Science Lectures in progress at the Victoria Hall and Coffee Tavern. The subject was that of American electrical fire alarms. In Boston and elsewhere, at the central fire-office, so perfect and ingenious were the arrangements that the same current of electricity which gave the alarm also opened the doors of the stables and released the horses from their tethering. The horses were then trained to place themselves in position on either side of the shafts of the fire-engine, they were harnessed with self-adjusting "snap" harness, and literally within six seconds of the first alarm the engine was on its way to the scene of danger. In asserting this, he was strictly narrating what he had seen and checked for himself, watch in hand, and of the truth of what he had said he gave his word of honour. He had been privileged to signal the alarm himself to a station one mile distant, and the horses came galloping up to the spot exactly four-and-a-half minutes afterwards. At the central offices of the Salvage Corps, too, wonderful things were done in the way of alacrity. Here the men slept in their under garments, and upon the bed were their trousers, which were sewn inside their boots. The bedclothes were attached to a wire, and at the first alarm were violently pulled off. At the same time a trap opened in the floor, and the men, while putting on their trousers, slid down an inclined plane into a vehicle below. Altogether it took them 13½ seconds to get out of the building fully equipped. Mr. Carpenter also described the self-acting fire alarms, which send a warning message directly the apparatus gets heated, and he pointed out that a practical testimony to their value lay in the fact that factories which employed them were insured by the fire offices at from one-half to one-third of the ordinary rates. The lecture was illustrated by lantern photographs and by experiments, all of which were projected on the screen.

Fire at a Telegraph Works.—We noticed the following in the *Evening Standard* of Saturday last:—An explosion occurred to-day at Siemens's telegraph factory, at Charlton, setting fire to the premises. The fire raged for 20 minutes, and was not extinguished before considerable damage was done. The cause of the explosion is unknown.

Soirée at University College.—On the evening of Wednesday, February 17th, Prof. A. B. W. Kennedy and the Committee of the Engineering Society held a most successful *soirée* at University College, London, in connection with the College Society. The Electric Apparatus Company and Messrs. Woodhouse and Rawson both gave electrical exhibits, which proved very popular. The College Society organised a show of photographs and photographic apparatus in the Library, where Messrs. Clarke & Clarke exhibited their method of printing by gaslight. They also gave a concert in the Botanical Theatre, the music being, through the kindness of the United Telephone Company, transmitted to a distant room. The *soirée* was attended by about 1,000 visitors.

Goolden and Trotter's Dioptric Glass Shades.—Among the glass shades supplied from Portsmouth for the installation on board H.M.S. *Devastation*, there were a dozen of the above, issued for comparison with the ordinary ground glass shades, and so greatly were the Trotter shades preferred, that the 12 were speedily appropriated for the officers' cabins. A similar issue is being made to all ships using the electric light, in order that a full report may be made as to their merits.

The Distribution of Electricity.—We may remind our readers that the Cantor lectures to which Prof. George Forbes refers in his paper, "Some Points in Electrical Distribution," were reported *in extenso* and illustrated in the columns of the ELECTRICAL REVIEW at the time of their delivery, viz., in the issues for February 7th, February 14th, and February 21st, 1885.

Pneumatic Propulsion.—Mr. Moon shows very clearly how uneconomical is the use of pneumatic tubes as a means of conveyance. The same thing was pointed out many years ago by the late Robert Sabine in an exhaustive report made by him upon the subject.

Nordenfeldt's Submarine Boat.—For full particulars of how this vessel behaves in action, together with a description of the electric shrimp torpedo and the self-acting telephone *vide Punch* of last Wednesday.

Conversazione.—A *conversazione* in connection with the Bradford Philosophical Society was held in the Technical College, Bradford, on the 10th instant. There was a large display of scientific apparatus, those having special reference to electricity being a collection of galvanometers, voltmeters and other apparatus from the Yorkshire College, Leeds. Two interesting cases were exhibited by Mr. Brodie, local agent of the Silvertown India Rubber, Gutta Percha and Telegraph Works Company. One contained shore-end and deep-sea cables, and the other showed India rubber in different stages of its manufacture. During the evening popular science demonstrations were given in the different lecture rooms. The Rev. J. R. Rendell, Yorkshire College, explained the recent researches by Prof. Hughes on the self-induction of an electric current, a set of apparatus similar to that used by Prof. Hughes in his lecture before the Society of Telegraph Engineers being shown. The elongation of a piece of soft iron during the time that a current of electricity is passing around it was also made clear to the audience by means of the movement of the ray of light upon the screen.

"Oh! Woodman Spare that Tree."—The *South Australian Advertiser* states that Lieutenant Immergosende (of the German Navy) and Dr. Kummel have explored North-East Guinea. They report that they reached a spot 12 days' march from the coast, and discovered that their compass was useless, owing to the presence of a tree which possesses the properties of a highly-charged electrical battery. Dr. Kummel was knocked down when he touched it. Analysis showed it to consist of almost pure amorphous carbon. It has been named Elsassia Electrica.

Complaints against the Blackpool Tramway.—*Gas and Water*, in a recent issue, says :—"Complaints against gas companies, both on account of smoke and smells, are less common than they were some years ago, the reason being that in these days every care is exercised to remove objections to the process of gas manufacture. The tables are now being completely turned. Gas companies instead of standing in the place of the accused are entering the lists as complainers against the smoke nuisance. An instance of this kind has just occurred at Blackpool. The gasworks property in that fashionable watering place appears to have been damaged by "black smoke" proceeding from the chimney belonging to the Blackpool Electric Tramway Company, and the town clerk has been instructed by the council to call the attention of the company to the nuisance. When the subject was under discussion on Tuesday it transpired that formerly there had been numerous complaints about the smoke from the electric light engines, but the smoke from the tramways furnace had proved a greater nuisance. Settling down upon all newly painted surfaces, the soot completely neutralised the efforts of the gas manager to give a clean and tidy appearance to the works. Let us trust the nuisance will be removed. It would not be very seemly to find the providers of gas and electricity in a court of law on a question of this kind." We quite concur in the closing sentiment of our contemporary.

Steam Engine Tests.—The journal of the Franklin Institute for the present month contains the report of the examiners upon the steam engines which were shown in the late Electrical Exhibition in Philadelphia. As none of the exhibitors made application for a competitive test as prescribed under the code, all tests are quantitative; and, for various reasons, the committee submits the report without any expression of opinion. The engines tried were the "Porter-Allen," the "Buckeye," and the "Southwark."

Gas v. Electricity.—At the annual meeting of the Midland Gas Managers' Association, held in Birmingham, the President, in referring to the future prospects of gas companies, said that he did not pretend that gas had nothing to fear from the electric light. With so many able men and busy brains at work on the subject, gas lighting might yet experience trouble from electricity; but there was no need for them to be afraid of it. He still believed gas property to be one of the safest of investments.

Electric Lighting of the Folkestone Exhibition.—The lighting of this exhibition, which it is intended to open on May 1st, has been entrusted to the Electrical Power Storage Company. It is proposed to employ arc lights for the central nave, refreshment rooms, and gardens; and incandescent lamps for the picture galleries. There will be in all 36 arc lamps of 3,000 candle-power, and 1,250 incandescent lamps. The dynamos and arc lamps used will be those of Messrs. R. E. Crompton & Co., and the engines will be supplied by Messrs. Marshall, Sons & Co., of Gainsborough; a set of E.P.S. batteries being used on each circuit, to act as regulators, and guard against the possibility of a total extinction of the lights.

At the meeting of the Anglo-American Brush Corporation, a report of which was published in our issue of the 12th inst., it was stated that the Corporation had the order for lighting this exhibition. Is not this a case of counting one's chickens, &c ?

Telephonic Experiments Abroad.—The correspondent of the *Standard*, telegraphing on Wednesday night from Vienna, says :—"The telephone trials between Brünn and Vienna, which commenced yesterday, were continued to-day, and have proved completely successful. The ordinary telegraph wire was used, without interruption of the service, and the words were not only audible, but the speaker's voice could be distinguished."

Electric Lighting in the Navy.—The work of fitting H.M.S. *Mersey*, at Chatham, with the electric light, which is being carried out by Messrs. Goolden and Trotter, under the superintendence of Mr. R. A. Scott, was commenced last week.

A trial has just been made at Portsmouth of an installation of the electric light, which has been fitted on board the *Impérieuse* by Messrs. Siemens Brothers and Company, who are also about to provide similar installations on board the *Warspite*, *Edinburgh*, *Collingwood*, and *Rodney*. The lights on board the *Impérieuse* comprise 375 incandescent lamps of 20-candle power, which are disposed so as to illuminate all parts of the ship including the engine-rooms, stokeholes, and magazines; and also a couple of search arc lights, placed at the bows and at the stern, and which are each equal to the power of 25,000 candles. The currents are generated by three Siemens's dynamos, on the combined and self-regulating principle, each of which is driven by one of Willans' compound two-cylinder engines, which is fixed to the same bedplate as the machine which it drives. The number of revolutions per minute is 400. The machines are interchangeable, and can be connected or thrown out of action by a simple switch arrangement. One of the machines supplies the search lights, and another is equal to maintaining 320 of the incandescent lamps aglow, which is considered as many as will be necessary as a rule to be alight at the same time. When the whole of the incandescent lamps are required to be lighted at the same time two dynamos will be demanded for the several leads, otherwise one will be kept as a reserve against accidents. The arrangements have been superintended on behalf of the company by Mr. Collings, and the preliminary trial during the day and after dark proved very satisfactory.

Telegraphic and Telephonic Communication.—At the meeting of the Associated Chambers of Commerce at the Westminster Town Hall, on Wednesday, the question of telephonic communication was discussed, and it was decided to request the Government to withdraw the monopoly they claimed in regard to telephones. There were four propositions upon the business paper with reference to the registration of telegraphic addresses; but these were concentrated in a proposal of the Southampton and Middlesbrough Chambers expressing the desirability of a considerable reduction of the registration of one guinea, and of the publication in the principal commercial centres of official lists of the registered addresses, and the firms using them. This was agreed to.

Domestic Electric Lighting.—We had hoped to be able to present our readers this week with a description of the electric lighting installation at Broomhill, Tunbridge Wells, the residence of Sir David Salomons, Bart. Pressure on our space, however, compels us to hold this over.

Direct and Counter Electromotive Forces.—We have received a paper reprinted from the American *Journal of Science* on "The Relation between Direct and Counter Electromotive Forces represented by an Hyperbola," by Prof. H. S. Carhart.

The Telephone.—The growth of the telephone (says the Boston, U.S., *Transcript*) is one of the most remarkable in the history of inventions. In August, 1877, the number of instruments in use in this country was only 780, while in February, 1880, there were 60,800, 249,700 in 1883, 307,010 in 1884, and in February, 1885, 325,574. There are about 18,000 in Canada, and 13,000 in Great Britain. The number of exchanges has grown from 100 in 1880 to 782 in 1885. In January last there were 137,223 miles of telephone wire in this country. There are 5,186 persons furnished employment by the exchanges. More different patents have been issued on the telephone than in any other single line of invention in this country. The total number for the ten years is 1,521.

Indian Telegraph Department.—Mr. Conybeare asked the Under Secretary for India, on Monday, whether it was the fact that the complaints of the officers of the Telegraph Department in the Government of India in respect of absence of promotion had been long admitted by the Government of India to be well-founded; whether any and what steps had been or were about to be taken to remedy their grievances; and whether he would communicate with the Government of India with a view of laying before Parliament at an early date all the papers relating to the subject. Sir U. Kay-Shuttleworth replied that the fact that there were grounds for complaint had been admitted, and was the subject of correspondence with the Government of India, with the hope of increasing the efficiency of the department and for remedying all just grievances. As soon as possible information would be given to Parliament.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES

Fischer Electro-Amalgamator Company, Limited.—An agreement, dated 8th inst. and filed on the 18th inst., confirms a preliminary contract of 9th September, 1885, for the purchase of certain patent rights from Mr. Max Wm. Weber, and authorises the issue to Messrs. J. Pearson Benwell and M. W. Weber of 1,500 fully paid shares.

Maxim-Weston Electric Light Company, Limited.—An Order of Chancery Division of the High Court of Justice, dated 6th inst. and filed on the 15th, authorises the reduction of the capital of this company in accordance with the resolutions passed and confirmed at the special meetings held on the 15th ult. and 1st inst.

Atlas Electric Appliances Company, Limited.—The annual return of this company, made up to the 15th inst., was filed on the 22nd inst. The nominal capital is £2,000 in £1 shares. 707 shares have been taken up and the full amount has been called and paid thereon.

Laing Electric Light and Power Company, Limited.—The annual return of this company, made up to the 15th inst., was filed on the 22nd inst. The nominal capital is £1,000,000 in 100,000 shares of £10 each. 12,007 shares have been taken up and the full amount has been called and paid thereon.

Hirsh, Greystock and Company, Limited (electricians).—The registered office of this company is at 11, Queen Victoria Street.

Railway Electrical Contractors, Limited.—Under an agreement of 29th October, 1885, filed on the 12th inst., Major Strutt, of 144, Leadenhall Street, is appointed managing director of the company, at a salary of £100 per annum and a commission of 10 per cent. on the net profits. The services of Mr. C. E. Houghton are retained as consulting electrical engineer, at a fee of ten guineas for each train fitted and lighted, or at such other fees as may be mutually agreed upon. A suitable assistant electrical engineer will be appointed, at a salary not exceeding £200 per annum, such engagement to be made by Major Strutt, subject to the control of the board. In order to provide working capital for carrying on and extending the business, the company agree to issue £5,000 of debentures at 6 per cent. per annum, or 1,000 7½ per cent. preference shares of £5 each. On any such issue, Major Strutt will have the option for six months from the date of the allotment, to take £1,250 or any less amount thereof at par. Major Strutt will, as soon as a resolution is passed authorising the issue of shares at a discount, pay to the company the sum of £500, and in consideration thereof and of services rendered, the company will issue to him the remaining 750 ordinary shares of the company as fully paid up.

NEW COMPANY REGISTERED.

J. E. H. Andrew & Co., Limited.—Capital £30,000 in £20 shares. Objects: To take over the goodwill and business of J. E. H. Andrew & Co., and to manufacture, buy, sell and deal in gas and electrical engines and motors and all apparatus used in connection therewith. Signatories (with one share each): *C. H. Andrew, Mrs. E. H. Andrew, and *Hugh Williams, C.E., of Stockport, Cheshire; *H. H. Andrew, J. A. A. Andrew, and T. Nicholson, of Sheffield; and E. Robinson Walker, of Manchester. Directing qualification, £1,000 in shares or stock. The signatories whose names are preceded by an asterisk are the first directors. The company in general meeting will determine the remuneration of the board. Registered 20th inst. by Waterlow Brothers and Layton, Birchin Lane, E.C.

LEGAL.

The United Telephone Company v. Bassano and Slater.—In the Court of Appeal, before Lords Justices Cotton, Bowen, and Fry, on Wednesday, an application was made by the plaintiffs to dismiss for want of prosecution an appeal presented by the defendants from the judgment of Mr. Justice North, on August 12th last, restraining the defendants from infringing the plaintiffs' patent of July 30th, 1877, for the Edison transmitter for telephones. The trial of the action in July last was fully reported in the REVIEW. On the 12th of August Mr. Justice North gave judgment as above stated, and also ordered the defendants to deliver up certain instruments which were in their possession. The learned Judge, however, postponed stating his reasons for his judgment, and he has not yet stated them. On September 23rd last, the defendants served notice of appeal. On December 4th a receiving order in bankruptcy was made against the defendants on their own petition, and in consequence of this the appeal could not be brought on in its proper turn. The plaintiffs, on the 19th inst., gave notice of motion that the appeal might be dismissed for want of prosecution. Mr. Ashton, Q.C., and Mr. Micklem, for the plaintiffs, now moved accordingly. Mr. Claude Plumptre, for the bankrupts and the Official Receiver, urged that until the learned Judge had stated his reasons for his judgment it was impossible for the Official Receiver or the bankrupts to be properly advised as to the prosecution of the appeal. The Official Receiver would have a *locus standi* by reason of the order for the delivery up of the instruments. Lord Justice Cotton said that the application was of a somewhat novel character. If the Official Receiver was carrying on the business of the bankrupts he would be interested in the injunction. And, notwithstanding the bankruptcy, the bankrupts were also interested in it, because it prevented them from carrying on their business by the work of their own hands, and if they committed a breach of it they would be liable to be sent to prison. The Court had ascertained from Mr. Justice North that he would state his reasons within a short time, and they thought that the proper order to make would be this—that if the bankrupts did not within a fortnight after Mr. Justice North had stated his reasons give security to the amount of £100 for the costs of the appeal, or the Official Receiver did not within the same time make himself a party to the action, the appeal should, without any further order, be dismissed without costs. If within the fortnight the bankrupts should give the security, but the Official Receiver should not make himself a party, the appeal would proceed as that of the bankrupts alone. On the other hand, if within the fortnight the Official Receiver should make himself a party, but the bankrupts should not give the security, the appeal would proceed as that of the Official Receiver alone. Lords Justices Bowen and Fry concurred.

The United Telephone Company v. Waltermann and Co.—In the Chancery Division, before Vice-Chancellor Bacon, on Saturday, counsel moved, on behalf of the plaintiffs in the above action, for judgment against the defendants in default of their not having put in any defence. The statement of claim, he said, alleged that the defendants had infringed certain of the plaintiff company's patents, the validity of which had been impugned in previous litigation, when the question was decided in favour of the plaintiffs, and went on to ask for an injunction in the usual form, to have the infringing instruments delivered up, and to have an enquiry in chambers as to the matter of damages, together with the costs, charges, and expenses, as between solicitor and client, to be paid to the plaintiffs. The claim for an enquiry as to costs between solicitor and client was under section 31 of the Patent Act of 1883. The Vice-Chancellor granted judgment in the terms asked for.

CITY NOTES, REPORTS, MEETINGS, &c.

The India Rubber, Gutta Percha and Telegraph Works Company, Limited.

THE twenty-second ordinary general meeting of this company was held at the Cannon Street Hotel on Thursday, the 18th inst., for the purpose of receiving the directors' report, which has already appeared in the REVIEW, and for other business. Mr. S.W. Silver, chairman, presided.

The notice convening the meeting having been read, and the report being taken as read,

The Chairman proceeded to move the adoption of the report, and, in doing so, said he thought he might allude to the occasion of their last meeting. It was a pleasure to meet, especially under such circumstances as they had the opportunity of doing that day. He then alluded to the issue of new shares, and he thought they might each congratulate themselves upon the result. The fact of the shareholders having supplied the board with the additional sinews of war would, in measure, account for the satisfactory state of things which, he hoped they felt with him, the board had the opportunity of putting before them that day. The operations of the year would, he was sure, bear comparison with any undertaking of a similar character. They must bear in mind that competition on all sides was so strong that their difficulty in getting orders was very great, and their difficulty in getting orders to leave anything like a margin of profit was still greater. Now, he did not think he need go into the question of figures, and detain them in doing so. These were a proof of the labours and the close attention on all sides to the interests of the company. They, he thought, showed very fairly as compared with previous years. The result of their net profits this year was within a very little of that of last year, leaving a disposable balance of £137,547, which, of course, included the premium upon the new shares, which, as they saw by their report, was passed to the reserve fund; so that after deducting a dividend of £41,600—that was £1 per share—they had a balance to carry forward of about the same amount as last year. As regarded work done, they had connected the Cape Verd Islands with the West Coast of Africa, and sold that cable to the Eastern and Brazilian companies. They had connected the Portuguese and French possessions on the Coast of Africa to the extent of 600 miles, and the remaining portion was in process of manufacture, and would be laid towards the close of the year, under a guarantee from the Portuguese of £42,000 and a subsidy from France of £12,000. Besides this, for the Government Indo-European Telegraph Department they had manufactured upwards of 500 miles; their steamers had conveyed the cable to the Persian Gulf, and that cable hadbeen laid most satisfactorily, their own people being present under the direction of Mr. Theophilus Smith. The whole of this operation had been referred to already in the *Times* of the 25th of last month. He alluded to it because it really gave a very satisfactory account of the whole proceedings, and they would agree with him they were not in the habit of blowing their own trumpet. They had in that a very satisfactory report of the manufacture of the cable, and of the employés connected with the India Rubber Company, and as to the state of the ships. They had several orders which they had executed for the Post Office, for the Western Union, for the India Office, and Western and Brazilian, so that they had been fairly occupied. With reference to the general state of the works, he might say electric lighting had not been overlooked by them. Should the time come for a general demand for that most delightful adjunct to their household, they were quite prepared to meet it, and that meant that their works were in very excellent order. They were in a position now, he might say, to complete an Atlantic cable under six months, and for their satisfaction he might tell them that the item of expenditure upon the works might be considered closed. It would not, he thought, be added to much further. Now, all this meant that much care and attention had been given by the manager, and by each member of their staff. That had not been brought about without a great deal of anxious and unceasing care and attention; and at once he was brought to the fact that he occupied the chair that day in the place of one whom to know was to respect. He fully endorsed the words that the report gave utterance to. He could add little to it but say that Mr. Geo. Henderson's attention was unceasing. In their anxiety to fill his place, they had persuaded his friend Mr. Gray to take a seat at the board. (Applause.) He was sure it would meet with their approval. In him they had, he might say, the lever, and to him might they attribute much of their success. Not only as regarded the works, the processes of manufacture, but also the selection of the employés, his judgment there had been proved again and again to be excellent. Their thanks were certainly due to the members of the staff, and he must not pass over his excellent friend, Mr. Hutchins, their solicitor, whose advice and counsel they had also great reason to be thankful for. Without further observations on his part, he did not think he ought to overlook the fact that in laying those cables, in the preparation for doing so, the soundings, and so on, Mr. Robt. Gray, Mr. Buchanan, and all others on board their steamers, had lost no opportunity of adding to the science of physical submarine geography. In Oxford the other day, in conversation with Prof. Moseley, whose name stood very high, he was glad to hear that the work was being fully recognised. With these observations, as they would have to refer to the special resolutions at the meeting that was about to take place, he would move, "That the report and accounts now presented be received and adopted, and

that a dividend of £1 per share, free of income tax, payable on and after the 19th instant, be now declared."

Mr. N. Bannatyne (director) seconded the motion.

Mr. Dixey said, as a shareholder, he would like to say a word or two with regard to the particular paragraph to which the Chairman had alluded. He (the speaker) referred to the paragraph which informed them of the death of their late Chairman, after having been 20 years a director and Chairman amongst them. In two or three touching sentences they were told that his health gradually declined, that he quickly passed away, but not without giving to his colleagues the benefit of his experience and sober judgment; and as that was the first general meeting since his decease, he thought it would be only a fitting thing that some grateful tribute of respect to his memory should be paid. They thought that day of his familiar face, of his kind and courteous conduct whilst occupying the chair; of the manner in which he received questions, and the courteous way in which he answered those questions, often throwing considerable light upon them. They thought of the words which he spoke, which were altogether words of inspiration and strength to them as members of that company, and never more so than when it was in its least prosperous condition; and though the chair which he had vacated was worthily filled, he thought they could not part with their friend without a feeling of deep sympathy with those members of his family and friends with whom he was most closely associated in life. That being so, he would venture to present to them a resolution, and he trusted that it would not want a seconder. He would not occupy their time further, but simply read the resolution:—"That this meeting, having heard with sincere regret the paragraph in the report announcing the death of Mr. George Henderson, desires to express its high appreciation of his personal character and worth, the uniform courtesy and consideration which distinguished him as director and chairman for more than 20 years, the strenuous efforts made by him in the interests of the company, which have contributed so largely to its development and present success; and this meeting further desires to express its cordial sympathy with his colleagues, and requests that a special message of condolence may be conveyed, through the Secretary, to the widow and members of his family, with a copy of this resolution." He (the speaker) left it with the meeting.

Dr. Small said, although not always at one with the late Chairman, yet he rose with very great pleasure to second the resolution. His conduct was always courteous and kind, and he quite endorsed the remarks made in the report. In times of difficulty he lent his name, as the report said, making himself personally liable on behalf of the company. He thought they would be unanimous in adopting the resolution.

The motion was unanimously agreed to.

Mr. Sutcliffe said that, according to the articles of association, the directors were to receive 10 per cent. remuneration upon the profits, in addition to the sum of £2,000. Although the report they had had before them that day was very satisfactory and pleasing to every one of them—and he hoped the success of the company would continue—yet it seemed to be an excessive amount to devote to the directors year by year. The amount that the directors took, according to the balance-sheet before them that day, was £4,700, giving to each gentleman about £1,200; and he supposed that the managing director had probably some remuneration beside. That was not shown, but he presumed that it was shown in the amount for salaries and general expenses, £56,342. He would like to know himself whether the managing director had a separate salary for managing this concern in addition to the amount paid to him. He (Mr. Sutcliffe) remembered the time when that company was not in the flourishing condition it was in to-day, when the shares stood at a great discount. He was at that time a shareholder, and at one time sold out his shares, but, fortunately, he bought them back again in good time. It seemed to him that the amount they gave these gentlemen for managing that company was excessive.

Mr. Hanson said what the directors received was strictly in accordance with a resolution passed five years ago. If dividends were not kept up, then the directors were simply to receive so much: if the company was successful, then they received a certain advantage.

Mr. Cattlin asked at what value the various steamers stood on the books.

Mr. Cochran asked if anything was being done in carrying out the work which was authorised by the shareholders some years ago, of establishing a building at Silvertown for the benefit of the working people. He thought that there was a good deal to be done to lighten the difficulties under which the working people existed—crowded together to a very great extent. He remembered very well that the shareholders acquiesced in the proposal made by the directors, but he had been unable to learn that any steps had been taken to put the resolution in force. There was a great deal of overcrowding in the district, and he should be pleased to know that the work would soon be commenced.

The Secretary at this point read a resolution agreed to on the 9th February, 1881, at a general meeting of the shareholders, which was to the effect that the ordinary remuneration of the directors should be £2,000 per annum, and whenever the shareholders received a dividend of 10 per cent. or more, the directors be entitled to receive additional remuneration; but in no case should the directors' remuneration exceed £5,000.

Mr. Gray, at the request of the chairman, replying to a previous question, said that the value of the steamers in the books was 40 per cent. less than they cost the company. For instance, one ship which cost £115,000, stood at £50,000; and another, which cost 45,000, stood at £30,000; and another, which cost £32,000, stood at £20,000; so that he thought they were in a pretty healthy condition. In reference to the public hall, he quite endorsed the necessity for having that hall and the various class rooms put up. But there had been nothing done except that detailed drawings had been made out, and the land was ready to receive the buildings when they were in a position to commence operations. The reason they had not done so before, was because they had been so very busy in the erection of their own works, upon which all their attention was more immediately concentrated. They had by no means lost sight of the project that had been referred to, and he hoped the shareholders would allow the matter to remain where it was until their hands were free to get at it.

The report was then agreed to.

Mr. Henderson said he rose with a very full heart to thank them and his friend near him, for the kind—and they would allow him to say, affectionate—words that had fallen with reference to his father. He was sure that could he have been present personally, nothing would have given him greater pleasure or greater gratification than to know that his efforts for the company had been so highly appreciated. He would not detain them, but would simply beg to return, on behalf of his mother and other members of the family, their warmest and hearty thanks for the sympathetic words and the kind resolution they had just passed. (Applause.)

Mr. Scott said it fell to him to propose that Messrs. Silver and Bannatyne, who retired by rotation, be re-elected as directors of the company. Both gentlemen were very large shareholders. They had worked well for the company, and he did not think he could name any two men in London better fitted to hold such an office.

Mr. Gray said he had much pleasure in seconding the motion; and it was agreed to.

The Chairman, in reply, said that in the name of himself and his co-director he begged to thank the shareholders for that mark of their renewed confidence, and assured them that their best exertions should be devoted to the interests of the company.

Mr. Kelso moved, and Mr. Sinclair seconded, a proposition that Mr. John Weise be elected auditor of the company's accounts for the present year, with a fee of 30 guineas; and the business of the general meeting then concluded.

An extraordinary general meeting of the company was then held, for the purpose of proposing the annexed resolutions, Mr. Silver again presiding. After the notice convening the meeting had been read,

The Chairman proposed the first resolution, which was as follows:—"The board of directors may from time to time appoint one of their number, or any other person, to be a managing director of the company, and may determine the amount of his remuneration and the term of his engagement, but no such engagement shall be for a longer period than five years. A managing director shall not retire from office by rotation during the period of his engagement." He said it would at once strike those who had had, like himself, much to do with business transactions, that promptitude was very often an important feature, that the board could not sit continuously, and that the managing director, having a seat on the board, could act in the interests of the company when, perhaps, anything might arise. He did not think there was any more argument necessary on that occasion to be used, but he would mention that the carrying of that resolution would not involve any increased expenditure in the management.

Mr. Bannatyne seconded the resolution.

Mr. Hancock said they were not told what the amount per annum would be; whereupon,

Mr. Bevan suggested that it would be hardly expedient that a private arrangement by which the directors managed the concern so successfully and satisfactorily should be detailed too fully. Mr. Gray was known to them as a first-class man. He had had, as they knew, some opportunity of judging of Mr. Gray's vigour and energy, and he could testify to his extraordinary qualities. It was not expedient that the question should be raised.

Mr. Gray said, as he was the particular person concerned, he could them tell frankly he had not the slightest objection to state the terms. (Cries of "No!")

The Chairman said there was no additional cost likely to arise to the company out of this arrangement. On the contrary, he felt it his duty to say that Mr. Gray was making a sacrifice, and that that sacrifice would be to the benefit of the *employés* of the institution. He need not say more in asking them to express their opinion.

The motion was then carried *nem. con.*

The Chairman, in moving the second resolution—which ran thus: "The number of directors (including any managing director) shall not exceed seven nor be less than four, and every director shall hold at least 100 shares in his own name as the sole holder thereof. The directors may from time to time appoint any additional directors or director, provided the number of directors shall never exceed seven"—said that they found the work very hard, or had found it so; and they, therefore, asked the shareholders to strengthen their hands; and he had great pleasure in moving that resolution. At present holding was nominal, no alteration had been made for years past in the clause concerning shares, and they considered that the holding of each director should be not less than £1,000.

Mr. Bannatyne seconded the motion.

Mr. Hancock suggested that the number of directors be nine

rather than seven. When that company was first started the number was 12; that number was reduced some years ago to five, and the directors had found that it was desirable to increase that number, and although the number seven would be a sufficient number for the regulations of the company—because he believed small boards worked better than large ones—still, at the same time, he thought they ought not to limit themselves too strictly. He thought they were exercising a wise discretion in keeping the number small.

The Chairman put the resolution to the meeting, and it was agreed to.

The Chairman then proposed, and Mr. Bannatyne seconded, the third resolution, as follows:—"The remuneration of the directors other than a managing director shall be from time to time determined by the members at the ordinary meeting; but any proposal for the alteration of the remuneration of directors shall be deemed special business, requiring seven days' notice to be given thereof."

Mr. Hancock said the question had been discussed at previous meetings, and it was decided that the remuneration henceforward be £2,000, and a further sum according to the profits of the company.

The Chairman said they did not propose to alter it.

Mr. Hancock, after some further remarks, said the directors should be satisfied with the decision then given.

The Chairman said they were quite willing.

Mr. Sutcliffe did not see any necessity for that resolution. The terms of the directors were stated in the company's books.

Dr. Small, referring to the last clause in the resolution, suggested that 14 days' notice be given when special business was to be transacted, and

The Chairman said that the directors had no objection to fall in with Dr. Small's suggestion.

The Chairman said they then came to the last resolution, which ran thus:—"The directors may from time to time sell, lease, exchange, or otherwise dispose of and deal with all or any parts or part of the property of the company situated in France upon such terms and in such manner as they may think expedient." If the board got the sanction of the shareholders, they would be able to act promptly; without it, they would have to go through a form that might, perhaps, place them in such a position as to lose a favourable opportunity of disposing of their works.

Mr. Bannatyne seconded the resolution, and it was agreed to without discussion.

Mr. Bevan proposed a vote of thanks to the directors for their services, and

The Chairman, in the name of his co-directors and himself, returned thanks. He said he had already referred to the attention given by the board to the interests of the company. Upon them much of the credit due to Mr. Gray had fallen, and he assured them that their attention to the interests of the shareholders would not slacken in the least, and he hoped to meet them 12 months hence with as satisfactory a report as they had on the present occasion rendered.

Maxim-Weston Electric Company, Limited.

THE fifth annual ordinary general meeting of the shareholders of this company was held on the 19th inst. at the Cannon Street Hotel, Mr. Hugh Watt, M.P., in the chair.

Mr. John Wright (the acting secretary) read the notice convening the meeting, and the report of the directors, published in the REVIEW last week, was taken as read.

The Chairman said: It is now a year since I had the pleasure of addressing you in general meeting. Since then we have had occasion to meet on two separate occasions, and I think I need not refer to the object of those meetings, except to say that immediately afterwards we secured the sanction of the court to the resolutions which had been submitted, passed, and confirmed by the shareholders. We secured that without the necessity of adding the word "reduced" to the title of the company, as is sometimes insisted on. On the last occasion, a year ago, when I addressed you, I ventured then to enter somewhat *in extenso* into the past history of the company. On this occasion I do not think it is needful or desirable that I should do so. I trust as long as we hold the position we do we will learn what lessons we can from the past and endeavour to utilise them for the advantage of the company in the future, and I do not think it would be either wholesome or desirable to go into the early and unfortunate history of this company. Well, gentlemen, I think I need not inform you further, as the report, I trust, has reached every shareholder. I have had a few complaints, and I mention this inasmuch as on a previous occasion we also had some complaints, but on this occasion I may mention, perhaps, that I personally supervised the forwarding to every shareholder the balance-sheets and report. It was, if I remember rightly, on Saturday; but we remained late and accomplished the work in one day, so that every shareholder might receive the statement simultaneously. Well, I do not think I need add that the financial position of the company to-day is stronger than it ever has been. I think the cash reserve at bankers and on deposit is sufficient to prove this fact, and I do think further that in view of the strong cash position of the company we are warranted in submitting to you a recommendation as to the payment of a dividend. I ventured, at an extraordinary meeting, after the business for which the meeting was convened, the only business which could legally be transacted at that meeting, had been closed, to submit a short statement as to the position of the company, the contracts which had been carried out or were in progress—a short *résumé* up to that date. This naturally leaves me very little to say to-day. The proposal that a suggestion should be made from the other side of the table with regard to the amount of dividend which we were entitled to, and ought to pay, led to the board making the recommendation which we shall do to-day, namely, to pay a dividend of 7½ per cent. upon the present amount of capital. Well, gentlemen, as I suppose I may assume that most of the hon. proprietors I have the pleasure of addressing to-day are business men, it is unnecessary for me to go into the general question of trade depression; you all, I am afraid, are only too familiar with that subject. It must, therefore, be, I think, to some extent, gratifying to the shareholders of this company that, passing under a crucial period such as the last year, we are able to come here to-day with a substantial profit after the payment of all legitimate and working expenses. In connection with another company, I saw a noble lord the other day ventured to submit what must be gratifying to all investors in electric lighting enterprise, the fact that electric lighting generally is improving. Well, I have pleasure in endorsing his sentiments. It is not only improving, but we have inquiries for it from the darkest, and may I almost add, from the uncivilised quarters of, I can hardly say, Christendom. Such being the case, and constantly receiving inquiries from all parts of the world for installations, we have had orders from nearly every colony, and have found them a more lucrative field than the home markets, containing as they do such a plethora of dynamos and other plant of almost every make and manufacture. We have, therefore, occupied our attention during the past year to a large extent with colonial and foreign trade, and during the last two months have made several of the largest shipments of electrical lighting plant upon order that have ever been made, I suppose, from this country, or almost any country. During the last year, I am happy to say that although our books do not show a largely increased value of plant to the profits, yet we turned out in weight—that is, in numbers of machines, lamps, and so on—a very much larger amount than last year. The reduced sale price of the plant was owing to the amount of competition we have had to submit to. Last year in addressing you for the previous year, I ventured to express the hope that we would be able to secure continued prices and a larger business. Such, however, did not turn out to be quite up to my expectations, and I have no hesitation in saying that the position of the company to-day, and the amount of business we have been able to carry through, have not been up to my expectation. I did not know at that time that other companies who were on the verge of liquidation, and who have since unfortunately gone into liquidation, had such a large amount of plant on hand, the result being that of course the liquidators of those companies in winding up the affairs of those companies had to submit to auction an enormous amount of plant. That naturally depressed very much the enterprise for the past year. At the same time I have pleasure in stating with regard to patents held by this company to date we are still in the forefront, and I do not think any better lamp has yet been discovered, although we have from day to day and from month to month, if I may say so, been kept upon the tenterhooks of expectation of something coming out which will entirely eclipse the Maxim-Weston. So far, nothing of the kind has happened. We have continually gone on experimenting and improving on our patents, and, partly with the view to that, we are on the eve of making arrangements for taking a larger factory, a place where we shall be able to manufacture not only what we are at present manufacturing, our own dynamos, but all the plant of the company, only excepting incandescent lamps. With regard to these, I have concluded such an arrangement with the American Company that I do not find it possible for us to go into the expense of laying down a special plant for incandescent lighting and carrying out that, as compared with the price to which I have been able to squeeze down the American Company. I may also say, as I have referred to the parent company in America, that so far they have met us very fairly. The only difficulty during the last few months has been their inability to supply us with sufficient despatch with the plant we have required. That is entirely owing to the enormous development of their business, and there are £2,000,000 or £3,000,000 profitably employed in the manufactures and installations of sub-companies of the American Company throughout the States of America. That I think is a sufficient guarantee that our plant is all it was promised to be when we took it over subject to such improvements as we have made. During the present year I hope we shall be able to improve considerably our arc plant. Our efforts hitherto have been mainly directed to endeavour, by means of experiment, to secure better results—that is, to enable us, through the same dynamo, to run a larger percentage of lamps, which of course proportionately cheapens the machine. In that way we have been able to a great extent to maintain the price of our various machines by securing, through winding and otherwise, better results in the number of lamps. Well, I hope during this year we shall be able, by undertaking the manufacture of this plant to save something like probably 20 to 30 per cent. upon the cost price of machines to us. This is a very material matter, because during the last two months I have been negotiating with almost every country in Europe, over and above the colonies, with the view of increasing our business. The result of that, as far as we know, is that the price charged us by the American Company virtually puts us out of the market in competing with the competitors on the Continent. I am in hopes, by means of larger premises, and the results which I think we shall obtain in the next three months in connection with the arc lamp, to be able to compete with a good profit with our Continental opponents. Their material is cheaper—their

iron is cheaper, labour is cheaper, premises and other expenses connected with the manufacture are cheaper, so that if we can manage to compete in places like Germany, that is about all, I think, we can hope to obtain with regard to the cost price of our plant. With regard to the premises, as we venture to mention this in the report, I may say that we have not secured the premises I named there, inasmuch as after a great deal of trouble and enquiry on our part I am in hopes to save about £200 a year in the rental of the premises we shall acquire, with a frontage of 6,000, 8,000, or 10,000 cubic feet. Our systems, I am happy to say, are growing in favour, and it seems like repetition to add that the Maxim-Weston installations have given great satisfaction. The last installation carried out and completed has been that in connection with Her Majesty's Post Office Department for the Government. I am happy to say, after numerous experiments, first of all directed to enable us to secure a steady non-flickering light by means of a gas engine, which we successfully overcame—I think I may say, in all humility, for the first time in the history of electric lighting companies; and the next thing by a sub-division of the light to obtain the greatest results and most varied at the lowest cost, for that really, after all, is the acme of electric lighting, and what we are all hoping to obtain in our competition with the greater power—gas. In connection with the installation in the Savings' Bank Department, there we had to contend with the difficulty of switching on and off from one room to another, and if we managed this in the case of 36 different circuits from the same machine, we would effect an economy varying from 30 up to 60 per cent. Well, gentlemen, we had no data to go upon; we had simply to rack our own brains, and find out, by means of a switch-board, what would answer all purposes to arrange from three machines a switch of 36 circuits. With the manager of our works, who is a man second to none in his profession, after some two months' time we have accomplished a switch-board, which the officials of the Post Office, including one of the best known, Mr. W. H. Preece, told me was entirely successful. We were met by the chief men connected with the Postal Department to investigate this installation. It was the first run, and, of course, the first run is not often the best, but Mr. Tough was so satisfied with regard to the switch-board, that we allowed the officials to be present at the test trial. The result was entirely successful, and after two or three hours' running, the Post Office officials were pleased to express their entire satisfaction, and to pass the installation. I may mention that we have entered into an agreement with the Post Office Department to run it for two years at a very handsome rental, thereby in a great measure guaranteeing the efficiency and the durability of our plant, a point we naturally base a good deal upon with regard to the future.

A Shareholder: Are they incandescent?

The Chairman: The installation is incandescent. There are at present 700 lamps running. I may say they intend duplicating this installation. One difficulty has been with regard to a tenant whom the Post Office authorities had arranged to buy out, and increased basement accommodation. When that is completed, I think I may safely say the Post Office will give us a duplicate contract. It is to be regretted that delay has taken place, but it is the largest installation we have ever undertaken, and I think, after the success which has attended it in enabling us to switch off from 36 different rooms on to any of three machines, that we are prepared to say we can carry out lighting of almost every description and of the most varied character. Well, gentlemen, we have done our best in the matter of increasing the number of agents. We have some valuable agents, who have got us a considerable amount of business during the last few months. Whether it is that our repute is going up from outside sources I do not know, but we have had enquiries from the first electrical agents throughout the country, England, and Scotland, for agencies for this company. Hitherto agents have been very much of this disposition, they have wanted all the profit to themselves. I have no objection to give an agent a fair commission, but I do object to allow him to get the entire profit in view of the fact that the company have expended £140,000 in connection with their patents. My colleagues and myself have endeavoured to put the report and balance sheet in as clear a form as we could. The first paragraph refers to the fact that during the past two years no sum had been laid aside for bad and doubtful debts and other contingencies, and we have now deemed it prudent to pass a sum of £3,606 5s. to the credit of a general reserve account. I mention this, because in taking larger premises we shall have to do a good deal in putting up fixtures, and that fund is available for that as well as other emergencies. During the last two years and nine months I do not think we have contracted £500 to £600 of bad debts. The total balance at the credit of profit and loss account is £5,284. Well on the last occasion, gentlemen, you thought proper to veto my proposal, which I daresay you will give me credit for having made in perfectly good faith, to declare a dividend. I have no wish to dispute the wisdom of the decision, but it enables us to declare a dividend in excess of what it would have been if the balance had not been carried forward. To-day, I think I may say, the company is in a position not only to warrant but to entitle us, to pay the dividend such as we propose of 7½ per cent. With regard to the Electric Lighting Act, that is somewhat a personal matter. I hope as soon as the present Government get fairly settled down to business, and this perpetual question of Ireland gets disposed of, I shall be able to induce the President of the Board of Trade to consider suggestions which I trust to have the pleasure of putting before him. In conclusion, the Chairman expressed his belief in the future of the electric light, although he said he did not take the sanguine views expressed at another meeting as to the numbers of people it would employ. He moved the adoption of the report.

Mr. Louis Swaby, in seconding the motion, said they did not intend to do what many other companies had done, namely, exhibition work at a loss. He thought they should give credit where credit was due, and he was sure the success of the Maxim-Weston Company was due to the chairman. He had had no light work. It had not been ten-to-four routine business; but Mr. Watt had devoted his time early and late, and had worked hard for this company, and he thought the whole of their thanks were due to him.

Mr. Griffiths had been informed that there had been an issue of new capital, and suggested that if new shares were issued they should be offered in the first instance to the shareholders.

The Chairman said there had been no new issue of shares, and the directors had not the power to make an issue without the consent of the shareholders.

The motion was subsequently carried.

The retiring directors and auditors were re-elected, and the directors were voted £500 for their services.

A vote of thanks to the chairman and directors then terminated the proceedings.

Telegraph Construction and Maintenance Company, Limited.

THE report of the directors states that the accounts for the year show a net profit of £82,740 15s. 8d. after charging the interest on the debentures. To this sum must be added £72,166 8s. 7d. brought forward from last year, making a total of £154,907 4s. 3d. From this amount is deducted the interim dividend of 5 per cent., paid July 21st, 1885, amounting to £22,410, leaving £132,497 4s. 3d. to be dealt with. Of this sum the directors propose to distribute a dividend of £1 16s. per share, absorbing £67,230, being at the rate of 15 per cent., and making, with the amount already paid, a total dividend for the year of £2 8s. per share, or 20 per cent., free of income tax, leaving £65,267 4s. 3d. to be carried forward to the next account.

The operations carried out during the year 1885 have been as follows:—

(A) In April a contract was entered into with Her Majesty's Government for the manufacture of 1,000 miles of submarine cable, which was completed in May.

(B) In the latter month a cable, 322 miles in length, was laid for her Majesty's Government from Shanghai, in Northern China, to Port Hamilton, off the coast of Korea.

(C) Between April and June a cable, 740 miles in length, was manufactured for the Eastern and South African Telegraph Company, and laid in August, as a duplicate line between Zanzibar and Mozambique.

(D) The Heligoland-Cuxhaven cable has been partially relaid and put in good working order.

(E) Early in the year the Fastnet Rock, 8 miles off the south-west coast of Ireland, was connected by a submarine telegraph cable with Crookhaven, as an experimental signal station for Lloyds, and, with the exception of one interruption, caused by heavy weather, it has continued to work up to the present time.

Telegraphic communication with the "Sunk" light vessel, stationed 9 miles off Walton-on-the-Naze, has been maintained with but slight interruption during the year, and since the experiment has taken its present form, it has been successfully maintained for 306 out of 311 days. Since the 11th of November communication has remained perfect, notwithstanding the unusual prevalence of heavy gales.

(F) In addition to the above-named operations, various lengths of cable, amounting to 763 miles, have been manufactured for several telegraph companies and Colonial Governments.

The company's steamships *Calabria* and *Kangaroo* have been chartered by Her Majesty's Government for condensing purposes in the Soudan for the periods of five and nine months respectively during the year. The steamships *Britannia* and *Seine*, reported as building and refitting in the last annual report, have been taken over by the company; and the whole of the company's ships, as well as the factories at Wharf Road and East Greenwich, are in efficient working order.

The Swan United Electric Light Company, Limited.

—An adjourned general meeting of the shareholders was held at the Cannon Street Hotel on Tuesday, when Mr. F. R. Leyland, who presided in the absence of Mr. J. S. Forbes, stated that as the negotiations with reference to the company's business had not been brought to a definite conclusion, it was desirable to further adjourn the meeting to Tuesday, 23rd March, at which date the report and accounts up to 30th September, 1885, would be submitted to the shareholders, and the position of the negotiations and of the business up to 31st December, 1885, be fully explained by the Chairman. The meeting was accordingly adjourned.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending February 19th were £2,560, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The Brazilian Submarine Telegraph Company, Limited. The receipts for last week amounted to £3,241.

NEW PATENTS—1886.

2290. "Electric testing apparatus." J. S. RAWORTH. Dated February 17.

2317. "Electrical switches." C. BROWETT. Dated February 17. (*Complete.*)

2322. "Method of metallising woven textile fabrics, especially flannel, in order to develop electricity for hygienic and medicinal purposes." L. A. GROTH. (Communicated by U. R. Pumariega.) Dated February 17.

2348. "Manufacture of arms or insulator bars for telegraph poles and telegraph insulators." D. WILSON. Dated February 17. (*Complete.*)

2372. "Electro-magnets." T. B. GRANT. Dated February 18.

2378. "Electric bells." S. A. VARLEY. Dated February 18.

2403. "Operating electric smelting furnaces." H. J. HADDAN. (Communicated by E. H. and A. H. Cowles.) Dated February 18. (*Complete.*)

2410. "Leclanché battery." A. LEVY. Dated February 18.

2433. "Dynamo-electric machines." T. A. GARRETT. Dated February 19.

2452. "Regulating or controlling engines driving dynamo-electrical machines." H. H. LAKE. (Communicated by E. H. Armet.) Dated February 19.

2456. "Holders for incandescent electric lamps." J. LEE. Dated February 19. (*Complete.*)

2470. "Electrical locomotion, propulsion, or traction and apparatus therefor." E. JULIEN. Dated February 19.

2479. "Electric cables." W. T. GLOVER. Dated February 20.

2494. "Instantly sending a signal by means of electricity for turning out fire engines, to be used in connection with an ordinary metallic telephone and electric bell circuit." F. E. STUART. Dated February 20.

2513. "Telegraphy." A. J. BOULT. (Communicated by B. B. Toye.) Dated February 20.

2525. "Electric conductors." J. G. PARKER. Dated February 22.

2554. "Lanterns for electric arc lamps." W. A. S. BENSON. Dated February 22.

2608. "Siphon recorders." W. P. THOMPSON. (Communicated by C. Cuttriss.) Dated February 23. (*Complete.*)

2615. "Absolutely continuous current dynamo-electric machines." C. J. HALL, W. LAWRIE. Dated February 23.

2625. "Primary electric batteries." R. HARRISON. Dated February 23.

2630. "Electrical indicators." B. J. B. MILLS. (Communicated by J. W. Howell.) Dated February 23.

2631. "Electric batteries." J. Y. JOHNSON. (Communicated by L. A. W. Desruelles.) Dated February 23.

2632. "Treating and preparing materials used in electric batteries." J. Y. JOHNSON. (Communicated by L. A. W. Desruelles.) Dated February 23.

2647. "Galvanic batteries." L. N. LOEB. (Communicated by J. H. Howard.) Dated February 23.

2648. "Galvanic batteries." L. N. LOEB. (Communicated by J. H. Howard.) Dated February 23.

2652. "Speaking telephone transmitters." W. C. TURNBULL. Dated February 23. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1885.

3260. "Improvements in secondary batteries or accumulators." J. PITKIN. Dated March 12. 8d. According to the invention the elements are constructed of a central plate or support of lead or other conductive material, against which the spongy lead or the peroxide of this metal is held by frames of ebonite and external perforated plates of the same material.

3332. "An improved ventilating armature for dynamo-electric machines." A. L. DAVIS. Dated March 14. 8d. Consists of an armature of the ordinary H iron shape, but instead of being either of solid iron or consisting of T shaped pieces, joined at the axis of the armature as is generally done, the armature is formed of discs of sheet iron of suitable thickness, punched out in shape of the end section of the aforesaid H iron armature with holes through each disc, near the periphery of such disc, through which pass two or more longitudinal bars or rods of metal. These bars or rods are covered with a tube or layer of ebonite or of other non-conducting substance, so as to effectually insulate them from the sheet iron discs, which discs are separated and kept at equal distances apart by alternate washers of iron and insulating material threaded on the longitudinal bars aforesaid. These bars are secured at each end to a plate or hub of gun or other non-magnetisable metal by means of suitable nuts and screws so as to ensure the rigidity of the whole structure. To these plates or hubs are again secured the journals or spindle on which the armature revolves.

3987. "An improved portable electric lamp." A. V. ROSE and G. F. ROSE. Dated March 28. 8d. The stand or pillar of the lamp constitutes or contains a receptacle for the electrolyte and elements of a battery, which elements are carried by a cover and consist preferably of carbons and zincs, the carbons being secured to the cover by screws and nuts or other means of attachment, the zincs being secured so as to be readily removeable by means of spring clip pieces with teeth or projections taking into recesses in the end of the zincs. The said elements are preferably in long narrow strips in series side by side and with non-conducting buttons or projections on the carbons to prevent contact between the elements due to distortion thereof. The clips which secure the zincs have thumb pieces projecting above the cover which can be pressed together to open the gripping jaws of the said clips and the bearing pieces of the clips on the elements may be made of platinum. Attached to the cover is a rack with which engages a pinion or toothed shaft carried by the lamp vase or cover by rotating which the elements can be raised or lowered all at the same time from or into the electrolyte.

4110. "Electric arc lamps." H. W. PENDRED. Dated April 1st. 8d. Refers to improvements in the lamp patented by the inventor No. 3210, February 13th, 1884.

8627. "Improvements in galvanic batteries and in the electrodes of electrolytic converting tanks or troughs." W. H. TASKER. Dated July 16. 8d. Relates to the construction of elements for galvanic batteries, particularly the negative elements of lead primary batteries, and it has for its principal object to provide a support for the active material or "depolarising agent" constructed of a substance which shall not be liable to become disintegrated by the effect of electrolysis, with means of making good conductive connection between the active material and the terminal of the element. The invention may also be applied to the electrodes of electrolytic converting tanks or troughs. The support is constructed of a foundation of gutta-percha, India rubber, celluloid, xylonite, or equivalent non-conducting and either inoxidisable or but slightly oxidisable substance, to which strips or wires, &c., of conductive and inoxidisable material (preferably gold or platinum foil) are applied in such manner as to be retained securely in place, and at same time make efficient contact with the active material.

CORRESPONDENCE.

Electric Alarms and Indicators.

We notice in your last issue a letter emanating from the pen of Mr. H. Albert, in which we are accused of using an idea of his to our own purposes. We should prefer passing this by and not giving you trouble or occupying valuable space in your journal by refuting it, were it not that such charges, however unfounded, are misleading to the general public, and apt to be injurious to us if allowed to pass unnoticed.

Now, the idea we are stated to have appropriated is, that when the disc of an electric indicator falls, it should complete a local circuit and cause the bell to ring until the said disc is replaced.

Had your correspondent taken the trouble to make enquiries, he would have found that such methods were known and in use long before the time he claims to have invented it. We, ourselves, could have given him the names of customers supplied by us with indicators containing similar arrangements eight or nine years ago.

From his concluding remarks, Mr. Albert seems to regret that it is not in his power to protect his inventions, but had he the means, it would certainly be a pity to waste them by taking out patents for things known to have been in use for years.

E. Thurkle & Co.

February 17th, 1886.

Telephone Patents.

Your correspondent "Combination," when he speaks of "the monopoly of the firm that will not sell telephones," cannot be aware that for many months past the New Telephone Company, Limited, has been selling telephones, "out and out," at reasonable prices. As he seems to suppose that a diaphragm is a necessity in a

transmitter, will you allow me to point out to him that in the valve telephones supplied by us, the transmitter has no diaphragm, the valve-piece standing clear in the top of the speaking tube, which is open from end to end. As I do not wish to use your correspondence columns for advertising purposes, I will not trespass further upon your space with descriptions of the instrument.

J. W. Barnard, *Secretary.*

New Telephone Co,. Limited,
4, Great Winchester Street,
London, E.C., *February 22nd*, 1886.

[The instruments used by this company (Prof. S. P. Thompson's) have already been described by us.—EDS. ELEC. REV.]

The Invention of the Telephone.

Dr. Lawson Tait in his letter, of which I have just seen the reprint in your columns (of January 15th), does me the honour to recall my name as that of a "very well-known man in Edinburgh" during his student years at the University, and he "feels almost certain" that he has seen me as "one of the frequenters" of a shop where Reis's telephone was exhibited in December, 1862. Dr. Tait "thinks it extremely likely" that I would go to the shop to see the telephone, and that I "might have been accompanied" by my son; and he further thinks that "nothing is more likely than that it was through this chain that Reis's telephone was transferred to America, and there became developed." Allow me to say that Dr. Lawson Tait's conjecture is entirely baseless. So far from being a "frequenter" of the shop referred to, I was never within its doors; and I never even heard of Reis's telephone until years after 1865, when I left Edinburgh. My son at the date specified by Dr. Tait was 15 years of age, and a pupil at the High School.

Knowing all the stages of my son's laborious efforts before he finally achieved the telephone, I know that his work was not suggested or directed by anything that Reis had done. At the time the telephone first began to speak, the whole world was astounded. The very idea was entirely new. Had Reis's instrument transmitted speech in 1862, how came it that the fact failed to be recognised as the marvel it undoubtedly must have been accounted? There is only one explanation. The sounds conveyed by Reis's instrument sometimes resembled words, or parts of words—as musical notes often do to imaginative listeners—but, as a matter of fact, Reis's telephone, without modification in accordance with the principle discovered by Alexander Graham Bell, has never, to this day, accomplished the transmission of an articulate sentence.

Alexander Melville Bell.

Washington, D.C.,
February 8th, 1886.

Some Points in Electrical Distribution.

We regret that we were unable to attend the meeting of the Society held on the 19th inst., but having seen the report of Professor Forbes' paper on the above subject in the last number of the Society of Arts Journal, we wish to draw attention to two statements made by him, and which we are surprised to see were not commented upon in the discussion which followed. The observations we wish to make relate to that part of his paper touching on secondary generators, and in which mention is several times made of the Grosvenor Gallery installation erected under our supervision for our clients, Sir Coutts Lindsay and Company, Limited. In speaking of *parallel distribution* by generators, Professor Forbes seems to labour under the impression that the same difficulties are met with as is the case in ordinary parallel lighting, viz., the fall of potential along the line, varying in proportion as the current is increased or diminished by generators being turned off or on. This fall of potential is dependent on the ratio that the amount of loss on the line itself bears to the maximum amount of work that is carried by the line. In the case of direct currents this ratio may be 10 to 20 per cent, while in the case of high tension currents it can be reduced as low as 1 to 1·5 per cent.

As the variations in potential must be proportional to the variations of the amount of work lost on the line—in the case of direct currents, where this variation may reach 20 per cent.—a corresponding *pro rata* variation in potential must be met in the manner mentioned by Professor Forbes, but where this variation is only 1 or 1·5 per cent. such precautions are not required, as generators or transformers in parallel are capable of maintaining practically the same potential in their secondary circuits, no matter where their position may be, or how the load along the line may be varied.

Again, speaking of generators in series, the lecturer stated that if "a double wire be used to prevent affecting telephones, it is half the weight"; but we fail to understand how he would propose to thus obviate induction on telephone lines, without at the same time doubling the weight of the entire conductor. We notice he gave no diagram of this proposed arrangement.

Another matter we cannot refrain from referring to is that of the automatic regulation of the secondary current when the generators are run in series.

The *modus operandi* seen by Professor Forbes, though practically originated by us, did not appear as successful in our estimation as it seems to have done in his, and for practical purposes has had to be abandoned.

Mackenzie & Brougham.

February 23rd.

Re Andersen's Formulæ.

In reply to "Ohm's" enquiry of last week, I wish to say that I think the formulæ in Part II. of my paper (November 21st and 28th), numbered II., III., IV., VI., and VII. respectively, the practical use of which is illustrated in the test-table with remarks, contain the guide required. The values of α and V will have to be decided for each case according to circumstances, that of F corresponding to a certain value of $\frac{w\,m}{W}$ must be known from tests made on the particular type of dynamo in question. In the old Gramme dynamo, it was ordinary to have by a value of $\frac{w\,m}{W}$ (proportionate waste in field magnet coils) of from ·12 to ·16, F equal to ·0075 to ·008. In modern dynamos we can find by $\frac{w\,m}{W} = ·04$ a value of F equal to ·013. I am not prepared for the present moment to publish any general formula for ascertaining F in a theoretical way.

F. V. Andersen.

February 23rd, 1886.

Private Telephonic Communication.

Will you please inform me whether I could fix a telephone line in Birmingham for own private use without having to pay any royalty; should I have to get permission from the Corporation or from the National Telephone Company, which is the only company in this town, buying another company's instruments? Sorry for taking up space.

H. Aston.

39 and 40, Smallbrook Street,
Birmingham.

[It would only be necessary for you to obtain permission from the owners of the property over which the line is to pass; no royalties would have to be paid either to the Corporation or to the National Telephone Company. You could not, however, work the line telephonically unless the instruments used were clear of the National Telephone Company's patent rights.—EDS. ELEC. REV.]